EVALUATION OF THE HUD LEAD-BASED PAINT HAZARD CONTROL GRANT PROGRAM

FIFTH INTERIM REPORT

Progress as of September 1, 1997

Prepared for
THE U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
by
THE NATIONAL CENTER FOR LEAD-SAFE HOUSING and
THE UNIVERSITY OF CINCINNATI DEPARTMENT OF ENVIRONMENTAL HEALTH

MARCH 1998

EVALUATION OF THE HUD LEAD-BASED PAINT HAZARD CONTROL GRANT PROGRAM

FIFTH INTERIM REPORT

Progress as of September 1, 1997

Prepared for

The U.S. Department of Housing and Urban Development

by

The National Center for Lead-Safe Housing and

The University of Cincinnati Department of Environmental Health

March 1998

NOTE from HUD:

The following report may contain pagination anomalies such as page number errors and differences of what is reported in the Table of Contents. These anomalies occurred when pages were formatted in the Adobe PDF format. These anomalies do not appear in the printed version from the National Center.

Table of Contents

Readers wishing detailed information about the Evaluation should contact the National Center for Lead-Safe Housing at (410) 992-0712.

List of Exhibits

APPENDIX EXHIBITS

INTRODUCTION AND SUMMARY OF FINDINGS

Introduction

The Evaluation of the HUD Lead-Based Paint Hazard Control Grant program is the largest and most comprehensive study of lead hazard control in housing ever initiated. Data collection began in 1994 and will continue until 1999. This interim report is the fifth of a series of reports that provide periodic updates on the progress of the 14 grant recipients that are participating in the Evaluation. This report offers initial findings based on the data that the grant recipients have submitted. The study is ongoing; not all data have been collected, edited or analyzed. Therefore, information that is contained in this report should be considered preliminary. This report is based on data collected and reported as of September 1, 1997.

The overall purpose of the Evaluation is to measure the relative cost and effectiveness of the various methods used by State and local government grantees to reduce lead-based paint hazards in housing. Measures include the levels of lead in dust, paint, and for some grantees, soil. Data are also being collected from most of the residents living in the dwelling units. Approximately 2,900 dwelling units will be followed for 12 months and approximately 750 units will be followed for 36 months.

This report is a testament to the hard work of the 14 grant recipients and the contributions of hundreds of families in this Evaluation. Although national in scope, this Evaluation is locally driven and implemented. Grantees design their own programs, including the methods of recruitment and the treatments that they carry out. At the end of this project, the data will not only provide the basis for the findings of the Evaluation, but will allow grantees to evaluate their own programs.

This report contains data from the 14 grant recipients (grantees) participating in the Evaluation. With 69 other grantees participating in the HUD Lead-Based Paint Hazard Control Grant Program, the number of dwelling units and families affected by the program is much larger than the numbers contained in these reports.

Summary of Findings

As of September 1, 1997, grantees had submitted clearance information for 2,158 dwelling units. Approximately 2,900 treated units will ultimately be part of the Evaluation. Thus, this report includes clearance results for 79 percent of those dwellings. Significant quantities of six and twelve month post-intervention data are beginning to be submitted. On September 1, 1997, 1,481 units of six month dust sampling data (51%) and 961 units of twelve month dust sampling data (33%) were submitted. These data offer an opportunity to look at preliminary findings. It must be noted that when all data are available, the final findings of the Evaluation may differ from those presented here. The main findings of this report are:

<u>Six Months After Treatment, Housing is No Longer a Significant Contributor to Blood Lead</u>

Preliminary statistical analyses indicate that the housing interventions appear to be successful in severing the link between children's blood lead levels and dust lead levels six months after the interventions are completed. Before the intervention, dust and blood lead were highly correlated. This suggests that the pathway between dust lead and blood lead was broken following the intervention. Thus, six months after the intervention, the lead hazard control activities appear to reduce dust lead levels to a point where they were no longer a significant contributor to the child's blood lead levels, a major achievement.

<u>Children's Blood Lead Levels Decline After Treatment</u>

Blood lead appeared to be much more likely to decrease than increase from pre-intervention to six and twelve months after the intervention. After adjusting for the child's age and the season, instances of children having *decreases* of 3 µg/dL (34%) or more were almost *five* times more likely than *increases* of 3 µg/dL (7%) or more at six months. Instances of children having *decreases* of at least 3 µg/dL (45%) were *nine* times more likely than *increases* of at least 3 µg/dL (5%) at twelve months.

<u>Household Dust Lead Levels Decline After Treatment</u>

Median dust lead levels on all tested surfaces (floors, window sills and window troughs) declined following the lead hazard control work. On floors, dust lead levels tended to further decline after clearance and remain low. On both window sills and troughs, dust lead levels tended to rise between clearance and six months after clearance. Window sill dust lead levels tended to remain the same between six and twelve months, while trough dust lead levels displayed small declines. Factors contributing to these possible trends will be explored.

Median Dust Lead Loadings at Four Phases of the Evaluation in (µg/ft^2)
(For dwellings with dust lead data submitted for all phases)

Dust Wipe Sample Location (Dwellings)	Pre-Intervention	"Clearance"	Six Months After Clearance	Twelve Months After Clearance
Interior Floors (557)	19	17	14	14
Interior Window Sills (547)	258	52	97	90
Window Trough (448)	14,350	61	770	657

Treatments are Durable

Six and twelve months after the intervention, few lead hazard control treatments had failed. Most of the commonly applied treatments failed in less than two percent of the rooms where they were conducted. The most likely reasons for failure were physical damage or inadequate installation.

Costs Vary Widely by Intensity of Work

In single-family dwelling units, the median lead hazard control cost to conduct cleaning and spot painting was about $700, while the median cost for units with window replacement and partial abatement of other components was just under $10,000. In multifamily dwellings, the median cost to conduct the interior treatments was $500 for low-level interventions and over $5,500 for units with partial abatement and window replacement. (Since the Fourth Interim Report one year ago, the number of dwellings for which window replacement treatments were reported more than doubled. The median cost of this treatment for both single and multifamily dwellings in the Evaluation is now about $1,500 less than was reported a year ago. With only about one half of the cost data for units in the Evaluation currently available, further substantial changes in reported summary statistics may occur.)

Clearance Testing is Important

Twenty-eight percent of the dwelling units failed the initial clearance dust lead test. This demonstrates the importance of dust clearance after lead hazard control. There is a wide variation in the clearance rates for the grantees, with rates of initial failure ranging from 8 to 50 percent. This finding warrants more investigation into why certain grantees (and their contractors) have been more successful.

Current Limitations of the Evaluation Findings

The scope of the findings will be restricted for dwellings with certain characteristics, because units with those characteristics were not commonly enrolled in the Evaluation. For example, with less than one percent of the enrolled buildings built after 1959, observations from this study about post-1960 buildings will be severely limited.

Overall, grantees have selected a broad range of lead hazard control strategies, especially on the interior of the dwellings. The study will have an opportunity to investigate the effectiveness of different intensities of treatments, from cleaning and spot painting up to and possibly including, complete abatement. However, information about soil treatments will be limited; so far, only 13 percent of the buildings with intervention data reported have had soil treatments.

The data reporting conventions of the environmental laboratories in the study pose a limitation on the analyses of changes in dust lead loadings. If a sample is reported as below the limit of detection prior to intervention, then in most cases decreases in dust lead after intervention will not be able to be quantified. Currently, 28 percent of the pre-intervention floor samples, and 12 and 2 percent of the pre-intervention window sill and trough samples are at the limit of detection. (At clearance, 48, 51, and 43 percent of the floor, sill and trough samples, respectively, were reported as below the limit of detection.) The Evaluation QA/QC Officer is now working on a pilot study to see if lower levels are retrievable from the laboratories.

Organization of This Report

This report begins with a *background* (page 5) section that explains the origins, purpose, and basic summary of the Evaluation. The background section also includes a brief description of each grantee's program. For readers who are familiar with the Evaluation, the background section may be bypassed. A *summary* (page 16) of the recent progress of the grantees follows the background section.

Interim findings (page 21) are presented in the third section of this report. The findings are based on the data that had been submitted as of September 1, 1997. The findings section and the corresponding exhibits, highlight some key observations and apparent tendencies emerging from the Evaluation. Results highlighted in this report include:

- characteristics of buildings and dwelling units;
- characteristics of lead hazard control interventions;
- a summary of lead hazard control costs;
- results of initial clearance testing;
- comparisons of dust lead levels before and after interventions;
- comparisons of blood lead levels before and after interventions, and
- a summary of treatments that failed at 6 and 12 months.

Because data are still being submitted to the Evaluation, conclusions should be drawn with caution. In order not to overstate any of the findings, the interim findings section follows a set of conventions when presenting data.

- Exhibits (tables and figures) only present grantee specific data when there are a minimum of 25 observations for a particular grantee.
- Exhibits present combined data from all grantees. The text notes when findings are heavily influenced by certain grantees.
- When the findings indicate that specific additional analyses are needed to interpret the results, plans for future analyses are discussed.

This report includes a section that highlights *plans for future analyses* (page 105). This interim report includes a section on costs by treatment. The section offers a glimpse at some of the specific component treatments that are being used and their reported costs, but also highlights the limitations of using such data at this time. (A previous report highlighted work on structural equation modeling and Typical Dwelling Unit descriptions. Interim findings from the structural equation models appear in Section V and VI of the interim findings. Summaries of six Typical Dwelling Units can be found on Exhibit 9.)

The final section of this report examines *laboratory performance* (page 109) on blood and environmental sample analyses. A short summary of results is presented. The section also includes a description of efforts to address results that were reported as below the detection limits of the laboratory.

An *appendix* is attached to this report updating findings from the fourth interim report about pre-intervention environmental results. For readers desiring more detailed, grantee-specific data, a Compendium of Tables with brief descriptions will be available upon request.

BACKGROUND

The Evaluation is a cooperative effort of 14 State and local government recipients of HUD Lead-Based Paint Hazard Control grants, the National Center for Lead-Safe Housing (the Center), and the University of Cincinnati Department of Environmental Health (UC). Fourteen of the first HUD lead-based paint grant recipients are collecting extensive data on environmental, biological, demographic, housing, cost, and hazard-control aspects of their activities with standard forms and procedures. The Center, a nonprofit organization devoted to helping public and private entities find effective and affordable ways to reduce lead hazards in housing, has overall responsibility for the Evaluation. Under a grant from HUD, the Center and UC designed the data collection forms and procedures and are providing training and technical assistance to the 14 State and local grantees. UC is performing the central data management role, including training and technical guidance in form completion and submittal, as well as quality control and development and management of central data files. The Center and UC are working jointly on data analysis and reporting.

The Evaluation was initiated in 1993, at the outset of the HUD grant program, to provide the earliest possible information to hazard control policy makers and program managers. It is broad in scope and complex to carry out, as are the programs it is designed to evaluate.

The main objectives of the HUD grant program, as stated in the 1992 Notice of Funding Availability (NOFA), are to:

> " (a) Encourage State and local governments to initiate or expand lead-based paint inspection, abatement, and training certification programs in order to reduce the health hazards associated with exposure to lead-based paint and lead dust, especially as these hazards affect young children in low- and moderate income households;
>
> (b) Encourage State and local governments to plan and implement cost-effective testing, abatement, and financing programs, including the testing of innovations that can serve as models for other jurisdictions interested in addressing this problem. Because of the high costs of eliminating lead-based paint hazards, particular encouragement is offered for programs that can safely reduce average per-unit abatement costs; and
>
> (c) Document the health effects of lead-based paint abatement activity by testing blood-lead levels of young children before and after abatement has taken place."

Furthermore, the NOFA stated the following design standard:

> "Grantees will be afforded considerable latitude in designing and implementing the methods of LBP hazard reduction to be employed in their jurisdictions. HUD is interested in promoting innovative and creative approaches that result in the reduction of this health threat for the maximum number of low- and

> moderate-income residents, and that demonstrate replicable techniques that are better, faster, less expensive or more effective than current practices."

Congress, which initiated funding for the grant program as part of the FY 1992 HUD appropriations bill, made it clear that the first round of funding was to be considered a demonstration program to examine the efficacy of various hazard control strategies. Congress stated that "provisions should be made for pre- and post-abatement dust-wipe sampling as well as initial and follow-up blood tests of occupants children to assist in quantifying the health benefits of abatement. Information should also be maintained on a house-by-house basis with respect to the actual abatement activities undertaken and the costs of such abatement."

A year later, Congress passed the Housing and Community Development Act of 1992, which required HUD to conduct research on;

- the efficacy of interim controls in various hazard situations;
- the relative performance of various abatement techniques;
- the long-term cost-effectiveness of interim control and abatement strategies; and
- the effectiveness of hazard evaluation and reduction activities funded by this act.

Participating Grantees

Eleven of the 14 grant recipients participating in the Evaluation are from the first round of grant awards, and three are from the second round (FY 1993 appropriations). Under the Congressional mandate, HUD required all first round recipients to participate in the Evaluation. Three grantees from the second round (Chicago, New York City and Vermont) were invited to participate on a voluntary basis. They were chosen to increase representation in the Evaluation of large urban areas with multifamily housing and of rural areas. A list of participating jurisdictions is found on the next page. It should be noted that there were only ten grant awards in the first round, but, for the purposes of the Evaluation, one subgrantee, Milwaukee, is considered an independent site.

Sixty-nine other jurisdictions have received or will receive grants from the HUD grant program in rounds two, three, four, and five, but HUD has not asked them to participate in the Evaluation because of budgetary limitations. It is expected that the 14 participating grantees will enroll and treat approximately 2,900 dwelling units in the Evaluation. Thus, the Evaluation will dwarf all previous studies of residential lead hazard control in terms of numbers of units.

GRANTEE	FUNDING (In Millions)	JURISDICTION	ROUND
Alameda County, CA	$4.41	Local	1st
Baltimore, MD	5.85	Local	1st
Boston, MA	3.66	Local	1st
California	6.20	State	1st
Chicago, IL	6.93	Local	2nd
Cleveland, OH	3.88	Local	1st
Massachusetts	6.00	State	1st
Minnesota	2.79	State	1st
New Jersey	4.25	State	1st
New York City, NY	6.75	Local	2nd
Rhode Island	4.07	State	1st
Vermont	3.20	State	2nd
Wisconsin	6.34	State	1st
Milwaukee*		Local	1st
Total	**$64.33**		

*Milwaukee is a subgrantee of the State of Wisconsin, but it is treated as a separate site for Evaluation purposes

Study Design

A challenge for the Evaluation designers was to develop a way to judge the cost-effectiveness of treatments without the use of control groups or random selection. Such research techniques were not compatible with the Congressional intent to have flexible, locally designed treatment strategies. Without these research techniques, the study had to collect additional data to determine whether changes in the principal outcome measures, dust lead levels and blood lead levels, might be the result of the lead hazard control work or other factors. Because children can be exposed to both lead-based paint in their homes and lead from other sources, the study tried to collect as much information about other sources as feasible. Twenty-three data collection forms were developed to collect information about ten major factors of interest.

The ten factors of interest are summarized in the list below and are outlined on **Exhibit 1**. The list includes the two principal factors that the study will evaluate: the environmental intervention (the scope of work) and its costs, and the two principal outcome measures: dust lead levels and blood lead levels. Data about another factor, soil lead levels, are being collected at the option of each grantee. Grant recipients in Alameda County, California, Milwaukee, Minnesota, Rhode Island, Vermont, Wisconsin, and Cleveland, volunteered to obtain soil information. Data about the remaining factors are being collected by all grantees so that the possible effects of these variables can be assessed.

Much of the information will be gathered four times during the study: prior to intervention, immediately after intervention, and six and twelve months after intervention. With this information, the study will be able to evaluate the costs and effectiveness of the intervention over a one-year period. Because HUD felt that longer periods of follow-up were needed to fully assess the costs and benefits of the different strategies, it provided support to nine grantees to collect information 24 and 36 months after the intervention from selected dwelling units. Grantees who are participating in the 24/36 month follow-up study include: Alameda County, Baltimore, Boston, California, Minnesota, Rhode Island, Wisconsin, Milwaukee, and Vermont.

Ten Factors of Interest in the Evaluation

1. Baseline Program Information - basic characteristics of the dwelling unit and the resident household (e.g., age of dwelling, tenure) at the time of enrollment into the study.
2. Dwelling Condition: Visual Inspection of Exterior/Interior - assessment of the general condition of the dwelling and of treatments following intervention. Visual inspection is part of the 24/36 month follow-up study.
3. Paint Inspection and Testing - description of the location and condition on all painted building components and measurement of the paint lead levels on those components.
4. Dust Sampling - measurement of dust lead levels on selected floors, window sills and window troughs (wells). Dust sampling is part of the 24/36 month follow-up study.
5. Soil sampling [optional] - description of the ground cover and measurement of soil lead levels at the building perimeter and at likely play areas. Soil sampling is part of the 24/36 month follow-up study.
6. Environmental intervention - description of all lead hazard control strategies and treatments.
7. Environmental intervention price - determination of costs associated with treatment of lead hazards.
8. Family interview - documentation of activities of the resident household that could confound or modify dust and blood lead levels. Household interviews are part of the 24/36 month follow-up study.
9. Occupant protection/relocation questionnaire - documentation of the experience of the household during intervention. Information may identify possible exposure of the resident child to lead hazards at the time of intervention.
10. Blood lead testing - measurement of blood lead levels of children between the ages of six months and six years who are enrolled in the study. Blood testing is part of the 24/36 month follow-up study.

Summary of Environmental Sampling

Dust - Dust is collected from 7-9 locations during each phase of the Evaluation. Single-surface dust wipe* samples are collected from the:

Floor: (bare or carpeted)	Interior Entry Kitchen Child's Play Room (or Living Room) Youngest Child's Bedroom (or Smallest Bedroom) Next Youngest Child's Bedroom [if present]
Int. Window Sill:	Kitchen Youngest Child's Bedroom (or Smallest Bedroom)
Window Trough: (Well)	Child's Play Room (or Living Room) Next Youngest Child's Bedroom [if present]

*Grantees have the option of collecting samples on carpet using a prescribed vacuum collection procedure.

Paint - X-ray fluorescence (XRF) paint tests are conducted on all interior and exterior painted component systems prior to intervention. When tests are inconclusive, or components are inaccessible by XRF, up to 10 laboratory paint chip tests are required.

Soil - Soil sampling is conducted at the option of the grantee. When conducted, composite soil samples are collected from two locations during each phase of the Evaluation:

Perimeter of Building
Child's Play Area in Yard

Readers wishing detailed information on the design of the Evaluation should contact the National Center for Lead-Safe Housing at (410) 992-0712.

Exhibit 1: Data Collection Schedule in Relation to Environmental Intervention

DATA COLLECTED	≤4 MONTHS BEFORE	≤6 WEEKS BEFORE	≤3 DAYS AFTER, PRE-OCCUPANCY	≤6 WEEKS AFTER	6 MONTHS AFTER	12, 24, 36 MONTHS AFTER
Baseline Program Information	x					
Dwelling Condition Visual Inspection Exterior/Interior	x		x		x	x
Paint Pb Inspection & Testing Exterior/Interior	x					
Dust Pb Sampling	x[1]	x	x		x	x
Soil Pb Sampling (Optional)	x		x		x	x
Environmental Intervention Description	x		x[3]			
Environmental Intervention Price	x[2]		x[3]			
Family Interview		x			x	x
Occupant Protection/ Relocation Questionnaire				x[4]	x[4]	
Blood Lead Test/Child		x		x	x	x

1 **Required only if educational information will be given to residents before the 6 week dust sampling phase. Pre-intervention dust sampling must occur before educational information is transmitted to residents to establish true baseline conditions.**

2 Estimate (optional)

3 Actual intervention and price as soon as possible after clearance

4 If Project personnel visit the home to draw the child's blood after the intervention, the Occupant Protection Interview should be conducted. If not, this questionnaire should be included in the 6 month follow up.

Development of Data Collection Procedures and Systems

As part of the program development process, the Center and UC have assisted each of the grantees as they integrated the data collection for the Evaluation into their plans. Because the quality of the Evaluation is dependent on the grantees reporting information that is comparable across all sites, the Center and UC developed data collection protocols and forms that are being used by all grantees. The Federal Office of Management and Budget approved the data collection forms and protocols in October 1993. (The Center also worked directly with the state of California to translate all interview forms into Spanish for its large Hispanic population. These forms are available for all grantees to use.)

UC developed a customized computer database system to handle the data collection needs. The grantees then worked with the Center and UC to determine how the data would be collected by the different agencies and private contractors participating in the Evaluation. The database is decentralized, with all grantees entering data into their own computers to facilitate analysis of local conditions. UC also developed procedures to send data to a central location at UC to be reviewed and processed into a central data system.

The Center modified a computer application ("Specmaster") developed by the Enterprise Foundation to collect a component-by-component scope of work of the lead hazard control activities for each dwelling unit. Like the UC database, the Specmaster database is decentralized and could be used by grantees to design their interventions. The treatment data, which includes the final cost of each treatment, are sent to the Center for review prior to final inclusion in the central data files.

The Center and UC carry out a number of activities related to monitoring and assuring data quality. They provide training to grantee field staff and data managers in data collection, forms completion, data entry, and data review. Periodic site visits, which include direct observation of data collection, are carried out to reinforce training and identify problems. Center and UC staff members are available as needed to answer questions related to the protocols. The Evaluation also includes measures to monitor and assure the quality of dust lead, paint lead, and blood lead measurements.

Summary Descriptions of Grantee Programs

This section provides a brief description of each of the 14 grantee programs participating in the Evaluation. The summaries describe the principal participants involved in the Evaluation, the jurisdictions in which the grantee works, the method of selecting dwelling units for funding, and the types of lead hazard control options selected.

Descriptions of the lead hazard control options use the terms "abatement" and "interim controls" as they are used in Title X of the 1992 Housing and Community Development Act. Abatement denotes that class of treatments that permanently remove or cover lead-based paint hazards. HUD defines permanent treatments as treatments expected to last at least 20 years. Building component removal, surface enclosure, and paint removal are common methods of abatement. Interim controls include treatments that eliminate immediate lead-based paint hazards, but do so in a manner that is not expected to last 20 years. Repainting, friction reduction on windows and doors, and cleaning are common interim control methods.

Alameda County

Alameda County is a first round county grantee that has targeted four high-risk cities (Alameda, Berkeley, Emeryville, and Oakland). The program is administered by the Alameda County Lead Poisoning Prevention Program. Many of the units that are enrolled contain lead-poisoned children. Buildings receive similar treatments, which include a mix of abatement and interim control work on interiors, minimal exterior work, and extensive treatment of the soil at the properties.

Baltimore

Baltimore is a first round city grantee that is targeting three neighborhoods in the city, while also enrolling homes city-wide. Two of the target neighborhoods contain a large percentage of investor-owned properties with histories of lead-poisoning, while the third is predominately owner-occupied. The program is managed by the Baltimore Lead Abatement Action Project of the city Health Department with support from the Baltimore Department of Housing and Community Development. All property owners who are enrolled in the program agree to bring their buildings up to basic housing standards before work begins. Many of the units, predominately rowhouses, are vacant at enrollment and intervention. Interventions include a mix of interim controls and abatement, including window replacement, but no soil treatments.

Boston

Boston is a first round city grantee. Lead Safe Boston and the Boston Childhood Lead Poisoning Prevention Program work together with families and property owners in three at-risk neighborhoods of the city. Most dwelling units that are enrolled in the program have received an order to abate based on the identification of a lead-poisoned child residing in the building. "Triple-decker" buildings are common in this program and often include a mixture of owner occupied units, rental units, and vacant units. In order to comply with Massachusetts regulations, treatments usually include significant abatement activities. No soil treatments are conducted.

California

California is a first round state grantee with four subgrantee communities (Los Angeles, San Francisco, San Diego, and Visalia (Central Valley). The state Department of Economic Opportunity and Department of Health Services work with Community Action Program (CAP) agencies in each of the communities to combine lead hazard control activities with weatherization work. Older homes in low-income neighborhoods are targeted. Treatments are fairly similar across subsites, with abatement activities occurring on interiors and exteriors of buildings and often including window replacement. Soil work is infrequently performed.

Chicago

Chicago is a second round city grantee. Five neighborhoods have been targeted by the program, with local community groups in each neighborhood serving to enroll and interview families. The program is managed by the Chicago Lead Safe Homes Initiative in the Chicago

Department of Public Health with support from the Chicago Department of Housing. Dwelling units are selected based on reports of lead poisoned children and after a special compliance hearing is held. All units will receive a mix of abatement and interim control work.

Cleveland

Cleveland is a first round city grantee that divides management responsibilities between the city Department of Health, and Environmental Health Watch, a nonprofit agency. Cleveland is conducting two programs: the Scattered-Site program (SSP) and the Intensive Neighborhood program (INP). Enrollment of units will be split roughly equally between the two programs. The SSP operates city-wide and targets families with lead-poisoned children. The units undergo a mixture of abatement and interim controls to all areas of the property, including the soil. The INP generally involves a less intensive and less costly set of remediations. The INP has two components. One is concentrated in a small area of often contiguous houses and includes a significant emphasis on resident education and involvement. The other component involves additional lead remediation in previously or concurrently rehabilitated units managed by a large nonprofit community development agency. These dwelling units are in contiguous neighborhoods with high rates of childhood lead poisoning.

Massachusetts

Massachusetts is a first round state grantee with four subgrantees (Brockton, Chelsea, Lawrence, and Worcester). The state Executive Office of Communities and Development and the state Department of Health are also working with two large multifamily complexes in Gloucester and Roxbury. The subgrantees have enrolled a mix of single family owner-occupied properties and investor-owned rental properties. Many of the buildings are under existing orders to abate their units because the presence, at some time, of a lead-poisoned child. In order to comply with Massachusetts regulations, treatments usually include significant abatement activities. No soil treatments are conducted.

Milwaukee

Milwaukee is a first round subgrantee of the state of Wisconsin that is being treated as a separate entity for evaluation purposes. The program is managed by the Milwaukee Department of Health with support from the Department of City Development. Milwaukee has targeted several of the lowest income neighborhoods in the city. Within those neighborhoods, dwelling units are selected from referrals to families with lead-poisoned children, from projects receiving HUD housing rehabilitation funds, and from direct outreach. Milwaukee targets occupied units with children. The city has four levels of intervention. The levels range from interventions in which only cleaning and education occur, through interim controls and abatement strategies, to substantial housing rehabilitation and abatement. No soil treatments are performed.

Minnesota

Minnesota is a first round grantee with three subgrantees (Duluth, Minneapolis, and Saint Paul). The grant is administered by the Minnesota State Housing Finance Authority, but most of the programmatic responsibilities have been delegated to the subgrantees. St. Paul and Minneapolis only target lead-poisoned children, while Duluth targets families with deteriorated housing conditions in areas eligible for assistance under the Community Development Block Grant program. All three grantees attempt to do some type of interim control such as paint stabilization and friction controls on all deteriorated lead painted surfaces. For some buildings, exteriors are enclosed with vinyl siding and other coverings.

New Jersey

New Jersey is a first round state grantee with 11 original subgrantee cities (Asbury Park, Beverly, Camden, Elizabeth, Englewood, Irvington, Jersey City, Newark, Paterson, Pemberton Township and Woodbine Borough). Four of these subgrantees (Asbury Park, Beverly, Pemberton Township, and Woodbine Borough) subsequently withdrew from the program. The program is managed by the Division of Housing and Community Development in the New Jersey Department of Community Affairs. All lead hazard control work will be integrated with concurrent comprehensive housing renovation/rehabilitation. Many units will be vacant prior to work. Funding for the work comes from several sources including HOME, CDBG, and state and local programs. Most units will receive full abatement and, in some cases, complete removal of all lead painted building components.

New York City

New York City is a second round city grantee. New York has targeted neighborhoods in Brooklyn, the Bronx and Manhattan that have the highest percentages of lead poisoning. It has three basic programs: two administered by the city Housing and Preservation Department, and a third program administered by the city Health Department. The Housing Department program blends lead grant funds with on-going housing rehabilitation programs. The enrolled buildings are generally multifamily buildings (6 to 20 units) where all units in the building will be addressed. The Health Department is administering a primary prevention program that targets families with newborn babies, living in deteriorated housing. The scope of work for primary prevention program is more limited, with the principal activities including interim controls of deteriorated, friction or impact surfaces. New York will not conduct soil work.

Rhode Island

Rhode Island is a first round state grantee that works throughout the state through 21 local housing offices. The program is administered by the Rhode Island Department of Health, Office of Environmental Health Risk Assessment. For a unit to be enrolled, it must meet Section 8 Housing Quality Standards, and the owner cannot own more than 12 units. The typical lead hazard reduction activities include some abatement work (window replacement and soil abatement) and interim controls to correct friction surfaces and defective paint.

Vermont

Vermont is a second round state grantee that works across the state. The program is managed by the Vermont Housing and Conservation Board. Vermont enrolls units from several different sources, including: the Vermont Health Department, which refers families with lead poisoned children; nonprofit housing developers that learn of the program when they apply for federal HOME funds; and unsolicited applications. Vermont performs a wide range of treatments. Projects managed by the nonprofit developers generally undergo substantial rehabilitation, while units that are privately owned generally undergo a lesser scope of work. Vermont has targeted one neighborhood in Burlington for a small project that involves only cleaning. Vermont rarely performs soil treatments, but has collected pre-intervention soil samples.

Wisconsin

Wisconsin is a first round state grantee with 12 subgrantees, not counting Milwaukee, which is treated as a separate grantee for purposes of the Evaluation. The subgrantees include: Chippewa County, Eau Claire County, Madison, Manitowoc, Oshkosh, Richland County, Rock County, Sheboygan, Superior, Wausau, West Allis, and Wisconsin Rapids. The program is administered by the Wisconsin Division of Health, but many of the program design decisions are made locally by the subgrantees. Each subgrantee has its own criteria for recruitment and selection of dwelling units. The scope of work also varies from city to city, depending on how the units were brought into the program and if the city is combining the lead grant with other housing rehabilitation funds. No subgrantee has reported any soil remediation, but they have collected pre-intervention soil samples.

GRANTEE PROGRESS

Completion of Interventions

Between September 15, 1996 and September 1, 1997, (the respective closing dates for data analyzed in the fourth and fifth interim reports) the grantees reported significant progress conducting lead hazard control work. By September 1, 1997, grantees had completed, cleared and documented interventions in 2,158 dwelling units, almost twice the number completed as of September 15, 1996 **(Exhibit 2)**. An additional 139 units were treated, but the final paperwork indicating the units had passed clearance had not been submitted as of September 1.

In October 1997, grantees provided a preliminary final count of all dwellings that were enrolled and treated as part of the Evaluation: 2,900 dwellings units. Thus, this report includes the initial clearance results from 79 percent of the treated units. Eight of the 14 grantees (Alameda County, Baltimore, Boston, California, Massachusetts, Milwaukee, Minnesota, and Vermont) provided initial clearance data on at least 90 percent of the units that they have treated in the Evaluation. Only New York City, which treated the most units in the Evaluation (over 480 dwellings), had not submitted initial clearance results for at least half of its treated dwellings as of September 1, 1997.

Dwelling Unit Enrollment

Almost 1,000 new dwelling units were enrolled in the Evaluation between September 1996 and September 1997 **(Exhibit 3)**. The number of dwelling units enrolled (as opposed to completed) increased to 3,556 units. During the period, Baltimore, New York City, and Cleveland each submitted enrollment forms for over 130 dwelling units.

As suggested above, not all of the more than 3,500 enrolled dwellings will be included as part of the study of Evaluation treatments. Some of the property owners who enrolled in the program decided to withdraw their dwellings before treatments occurred. Other properties will receive HUD funded treatments, but will receive them too late to be included in the Evaluation. The final disposition of the extra 600 plus dwellings was not known at the writing of this report. Baseline data from these extra dwellings are included in this report when available.

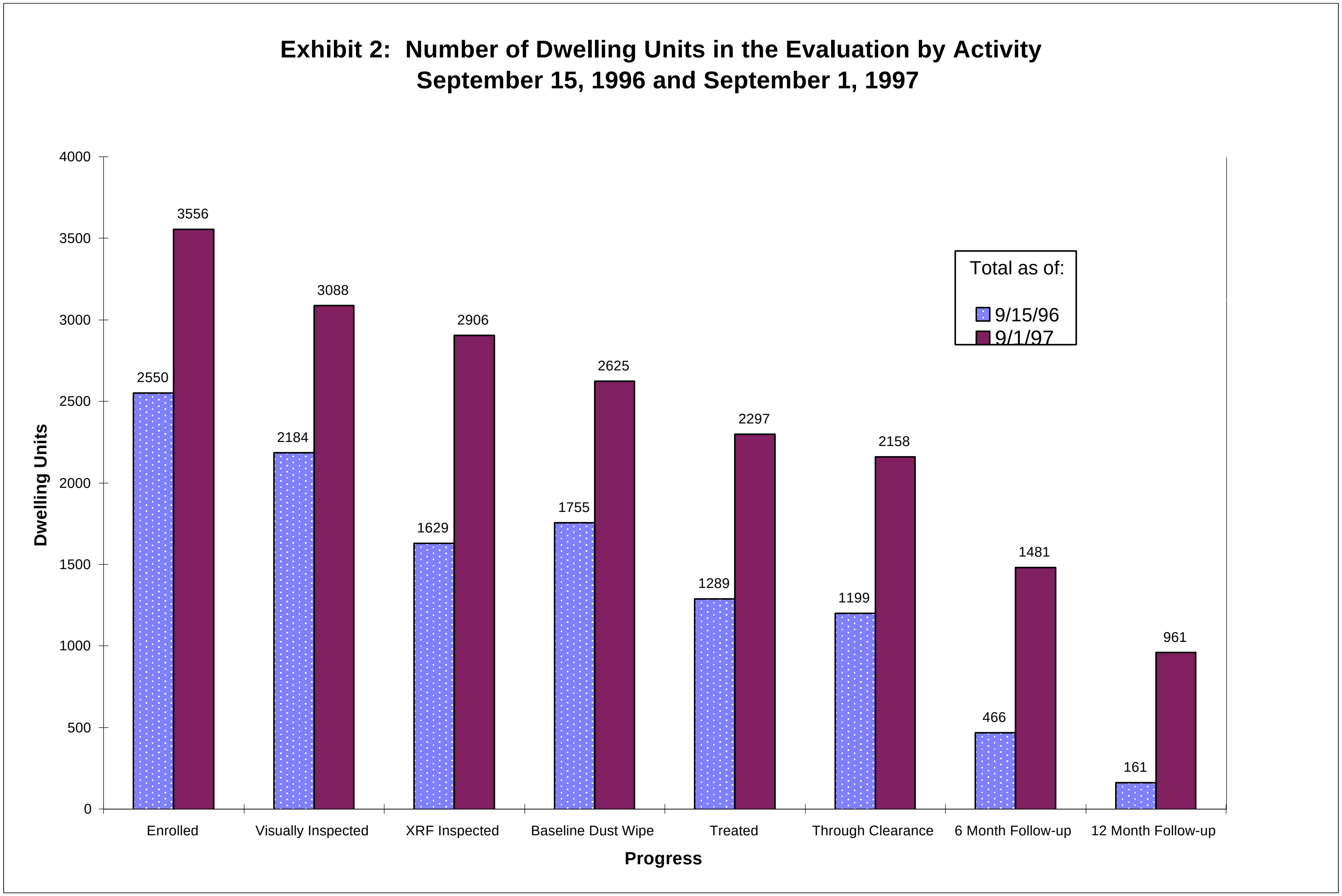
Collection of Dust Lead Results

From September 15, 1996 to September 1, 1997, the number of dwellings for which baseline dust wipe data had been submitted increased by 50 percent to 2,625 **(Exhibit 2)**. Even more significantly, the number of 6 month and 12 month dust wipe results greatly increased. The 6 month dust data more than tripled from 466 to 1,481 and 12 month dust data increased almost six-fold from 161 to 961 dwellings. While these additional data will allow this report to identify more trends than were previously apparent, the results still reflect only about half of the 6 month and a third of the 12 month inspections of the dwellings that have been treated in this Evaluation. The 12 month dust results are principally (64%) represented by data submitted from just four grantees: Baltimore, Milwaukee, Minnesota, and Vermont.

Household Enrollment

Grantees reported data on 2,432 households currently enrolled in the Evaluation **(Exhibit 4)**. Information on the ages of children was available for 1,550 (64%) of these households. This number includes only households enrolled in the Evaluation prior to the intervention for which household interview data had been submitted. One thousand, one hundred seventy-four (1,174) of these enrolled households included children less than six years of age. Pre-intervention blood lead data from samples collected by grantees were reported for 1,181 of the 1,933 children enrolled (61%).

Pre-intervention blood lead measurements for some children were collected outside of the study and are not reported here. These data may be available for use in later reports. Anecdotal information suggests that children whose blood lead levels were tested outside of the study are more likely to be children who were lead poisoned prior to enrollment. These data will enhance the ability of the Evaluation to meet its objective of estimating the impact of the interventions on the blood lead levels of young children.

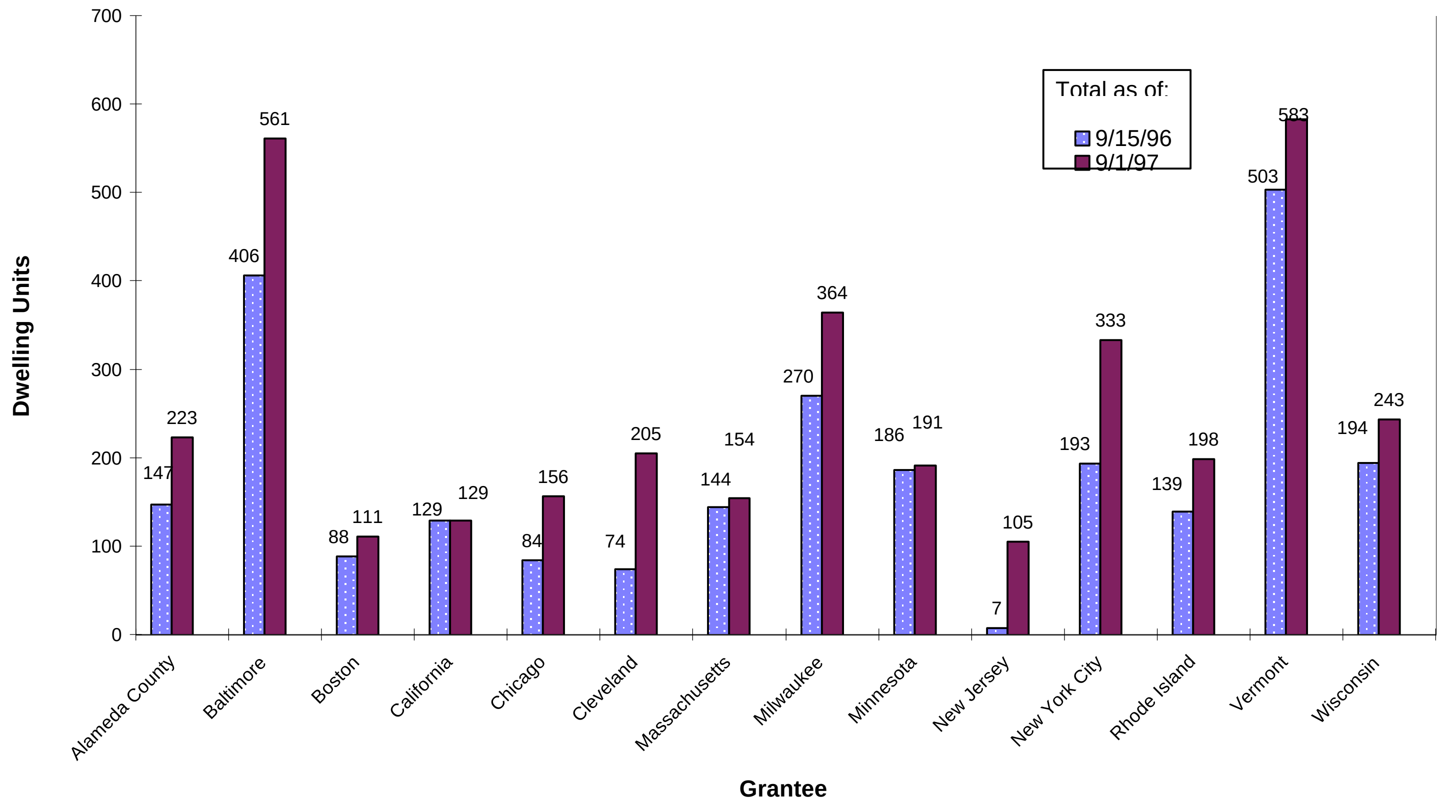


Data From: Forms 01, 11, 15, 19 (Phases 01, 02, 03, 04), 20.

Data as of: September 1, 1997

Source of Data: UC Table 12 (November 12, 1996) and Table 12 (October 1, 1997)

Exhibit 3: Number of Dwelling Units Enrolled in the Evaluation by Grantee September 15, 1996 and September 1, 1997



Data from: Form 01.
Data as of: September 1, 1997
Source of Data: UC Table 12 (November 12, 1996) and Table 12 (October 1, 1997)

Exhibit 4: Enrollment of Dwelling Units, Households and Children

Number of	Enrolled Dwellings	Enrolled Households	Enrolled Children
Dwellings Enrolled	3,167		
Dwellings with Enrolled Household(s)	2,330		
Enrolled Households		2,432	
Enrolled Households* with interviews completed		1,550	
Enrolled Households with Children under 6*		1,174	
Children under 6*			1,933
Children under 6 with Baseline Blood Test			1,181

***** Information on persons in households is based on family interviews conducted after enrollment.

Data from: Forms 01, 04, 09.

Data as of: September 1, 1997

Source of Dwelling Data: UC Tables 12 and 68.

Source of Household Data: UC Tables 14, 68, and 336.

Source of Child Data: UC Tables 14 and 24.

INTERIM FINDINGS

I. Characteristics of Buildings and Dwelling Units Enrolled in the Evaluation

The Third Interim Report on the Evaluation suggested that the effectiveness of lead hazard control activities is likely to vary according to dwelling characteristics. Two years later, evidence is beginning to emerge that supports this hypothesis. Interim findings are presented at the end of Section V in this report suggesting that building type and house age, among other factors, influence pre-intervention floor dust lead loadings and the pre-intervention levels influence floor lead dust loadings collected six months post-intervention. Such findings underscore the need to recognize both the variation in types of housing enrolled by grantees and the overall housing stock that has been enrolled in the Evaluation. Any interpretation of the effectiveness of the lead hazard control treatments performed by the grantees must be conducted with the characteristics of the enrolled buildings and dwelling units in mind.

Types of Buildings Enrolled

Of the over two thousand buildings enrolled in the Evaluation as of September 1, 1997, 57 percent were single-family buildings (**Exhibit 5**). Slightly less than a third of all buildings (32%) were single-family detached dwellings while a quarter were single-family attached (rowhouse) buildings. The building type most commonly enrolled by seven of the fourteen was a single-family detached dwelling. For six of these grantees, at least 50 percent of the buildings that they enrolled were single-family detached. Meanwhile, Baltimore was reasonably unique in enrolling rowhouses. Ninety-two percent of buildings enrolled in Baltimore were rowhouses, while 95 percent of all rowhouses enrolled in the Evaluation were from Baltimore.

Another common grouping of building types were small multifamily structures. Thirty-seven percent of the buildings enrolled were either two, three or four-unit structures. The configuration of these units tended to reflect common regional building styles. In urban areas of New England, the three-family “triple-decker” is a common construction style. Correspondingly, the triplex was the most common building type in Massachusetts, Boston, and Rhode Island. These three grantees, plus Vermont, contributed 77 percent of the three-family buildings enrolled in the Evaluation. Vermont also tended to enroll four, six and eight-family buildings. In the Midwest, the small multifamily buildings are more likely to be two-family “two-flats.” A majority of the buildings enrolled in both Milwaukee and Chicago were two-family buildings.

Six percent of the buildings contained more than four dwellings. These larger multifamily buildings made up 85 percent of the enrollments in New York City. On average, these New York City buildings contained 14 enrolled dwelling units reflecting the city’s larger (and taller) style of housing. Another substantial contributor of larger multifamily buildings is the previously mentioned Vermont, which enrolled a range of both the six and eight-unit buildings and larger complexes.

Age of Housing

The vast majority of the buildings (90%) enrolled in the Evaluation were built before 1940 when lead-based paint was heavily used in residential painting (**Exhibit 6**). Even though all

Exhibit 5: Number and Percentage of Buildings by Type of Building and Grantee

Grantee	Type of Building						
	Single Detached	Row-house	Two Family	Triplex	Fourplex	>Four Units	Total Number of Buildings
Alameda Cty	81	0	34	7	4	6	132
	61.4%	*0.0%*	*25.8%*	*5.3%*	*3.0%*	*4.5%*	*100%*
Baltimore	19	499	18	1	2	1	540
	3.5%	*92.4%*	*3.3%*	*0.2%*	*0.4%*	*0.2%*	*100%*
Boston	11	1	20	42	1	0	75
	14.7%	*1.3%*	*26.7%*	*56.0%*	*1.3%*	*0.0%*	*100%*
California	42	17	7	2	1	5	74
	56.8%	*23.0%*	*9.5%*	*2.7%*	*1.4%*	*6.8%*	*100%*
Chicago	29	2	59	13	3	9	115
	25.2%	*1.7%*	*51.3%*	*11.3%*	*2.6%*	*7.8%*	*100%*
Cleveland	92	0	45	2	2	2	143
	64.3%	*0.0%*	*31.5%*	*1.4%*	*1.4%*	*1.4%*	*100%*
Massachusetts	11	3	24	40	2	14	94
	11.7%	*3.2%*	*25.5%*	*42.6%*	*2.1%*	*14.9%*	*100%*
Milwaukee	86	1	122	7	15	3	234
	36.8%	*0.4%*	*52.1%*	*3.0%*	*6.4%*	*1.3%*	*100%*
Minnesota	79	1	40	5	12	6	143
	55.2%	*0.7%*	*28.0%*	*3.5%*	*8.4%*	*4.2%*	*100%*
New Jersey	13	3	4	0	2	4	26
	50.0%	*11.5%*	*15.4%*	*0.0%*	*7.7%*	*15.4%*	*100%*
New York City	0	0	0	0	4	23	27
	0.0%	*0.0%*	*0.0%*	*0.0%*	*14.8%*	*85.2%*	*100%*
Rhode Island	26	0	20	32	2	5	85
	30.6%	*0.0%*	*23.5%*	*37.6%*	*2.4%*	*5.9%*	*100%*
Vermont	76	1	47	34	35	41	234
	32.5%	*0.4%*	*20.1%*	*14.5%*	*15.0%*	*17.5%*	*100%*
Wisconsin	114	0	42	6	7	2	171
	66.7%	*0.0%*	*24.6%*	*3.5%*	*4.1%*	*1.2%*	*100%*
All Grantees:	679	528	482	191	92	121	2093
	32.4%	*25.2%*	*23.0%*	*9.1%*	*4.4%*	*5.8%*	*100%*

Data from: Form 01, Question 01

Data as of: September 1, 1997

Source of Data: UC Table 4

Exhibit 6: Year Building Constructed by Grantee

Grantee	Period of Building Construction					
	Pre 1910	1910-1919	1920-1929	1930-1939	1940-1969	Total Number of Buildings
Alameda Cty	51	24	34	10	13	132
	38.6%	*18.2%*	*25.8%*	*7.6%*	*9.8%*	*100%*
Baltimore	207	54	160	49	70	540
	38.3%	*10.0%*	*29.6%*	*9.1%*	*13.0%*	*100%*
Boston	24	25	12	8	6	75
	32.0%	*33.3%*	*16.0%*	*10.7%*	*8.0%*	*100%*
California	3	11	23	12	26	75
	4.0%	*14.7%*	*30.7%*	*16.0%*	*34.7%*	*100%*
Chicago	19	25	52	9	10	115
	16.5%	*21.7%*	*45.2%*	*7.8%*	*8.7%*	*100%*
Cleveland	74	43	24	1	1	143
	51.7%	*30.1%*	*16.8%*	*0.7%*	*0.7%*	*100%*
Massachusetts	48	19	19	5	3	94
	51.1%	*20.2%*	*20.2%*	*5.3%*	*3.2%*	*100%*
Milwaukee	134	54	36	2	8	234
	57.3%	*23.1%*	*15.4%*	*0.9%*	*3.4%*	*100%*
Minnesota	95	30	15	0	2	142
	66.9%	*21.1%*	*10.6%*	*0.0%*	*1.4%*	*100%*
New Jersey	5	11	5	3	2	26
	19.2%	*42.3%*	*19.2%*	*11.5%*	*7.7%*	*100%*
New York City	12	4	8	3	0	27
	44.4%	*14.8%*	*29.6%*	*11.1%*	*0.0%*	*100%*
Rhode Island	23	13	17	11	20	84
	27.4%	*15.5%*	*20.2%*	*13.1%*	*23.8%*	*100%*
Vermont	162	21	25	6	21	235
	68.9%	*8.9%*	*10.6%*	*2.6%*	*8.9%*	*100%*
Wisconsin	71	26	44	13	19	173
	41.0%	*15.0%*	*25.4%*	*7.5%*	*11.0%*	*100%*
All Grantees:	928	360	474	132	201	2095
	44.3%	*17.2%*	*22.6%*	*6.3%*	*9.6%*	*100%*

Data from: Form 01, Question 02

Data as of: September 1, 1997

Source of Data: UC Table 5

grantees tended to enroll buildings constructed prior to World War II, there is some variation between grantees. The overall median year of construction of an enrolled building was between 1910-19. For five grantees (Cleveland, Massachusetts, Milwaukee, Minnesota and Vermont), their median year of construction was prior to 1910. Four other grantees tended to enroll buildings that were newer than the overall median. The median enrolled building in Baltimore, Chicago, and Rhode Island was built in the 1920s, while California's median year of construction was in the 1930s.

Occupancy Status

Another factor that has been found to influence pre-intervention dust lead levels is the occupancy status of the dwelling. Out of the 3,556 dwelling units that were enrolled as of September 1, 1997, 761 units were vacant prior to intervention (**Exhibit 7**). The number of dwellings that were vacant prior to intervention widely varied by grantee. Baltimore had a vacancy rate of 60 percent and contributed 41 percent of the total vacant units. Vacancy rates in Vermont, New York City and New Jersey ranged from 24 to 34 percent; no other grantee had a vacancy rate above 14 percent. While the overall vacancy rate was 22 percent for the Evaluation, the vacancy rate for the ten grantees not previously mentioned was just nine percent. Massachusetts and Chicago had vacancy rates of only three percent.

Building Deterioration

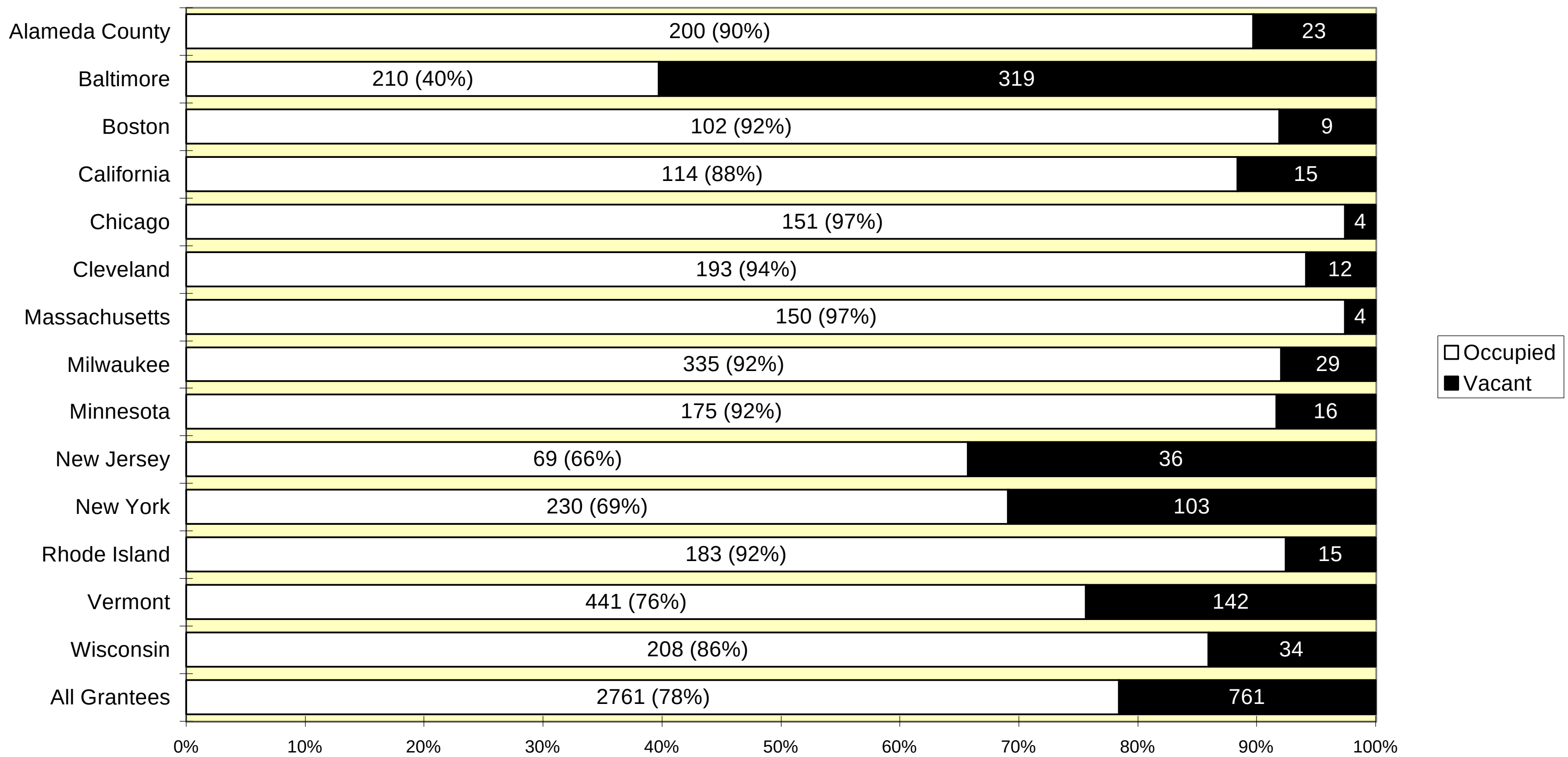
Forty-six percent of the exteriors of buildings and 48 percent of the interiors of dwellings had a major building component (i.e., roof, wall, door, etc.) with obvious and extensive deterioration (**Exhibit 8**). Grantees enrolled buildings with levels of deterioration that differed from other grantees. Cleveland appeared more likely to enroll buildings with *interior* or *exterior* deterioration, while Alameda County and Wisconsin were less likely to enroll buildings with *interior* or *exterior* deterioration. New Jersey and Baltimore were more likely than other grantees to enroll dwellings with deteriorated *interior* building components, while Rhode Island and Chicago were less likely. Vermont was more likely to enroll buildings with deteriorated *exterior* building components.

The building components were assessed by inspectors who received training to rate the components according to a single protocol. It is recognized that some variation between the rating systems of the inspectors did exist, but overall, any variation in rates of building component deterioration between grantees is expected to reflect actual differences in condition.

General Impact of Building Characteristics on the Evaluation

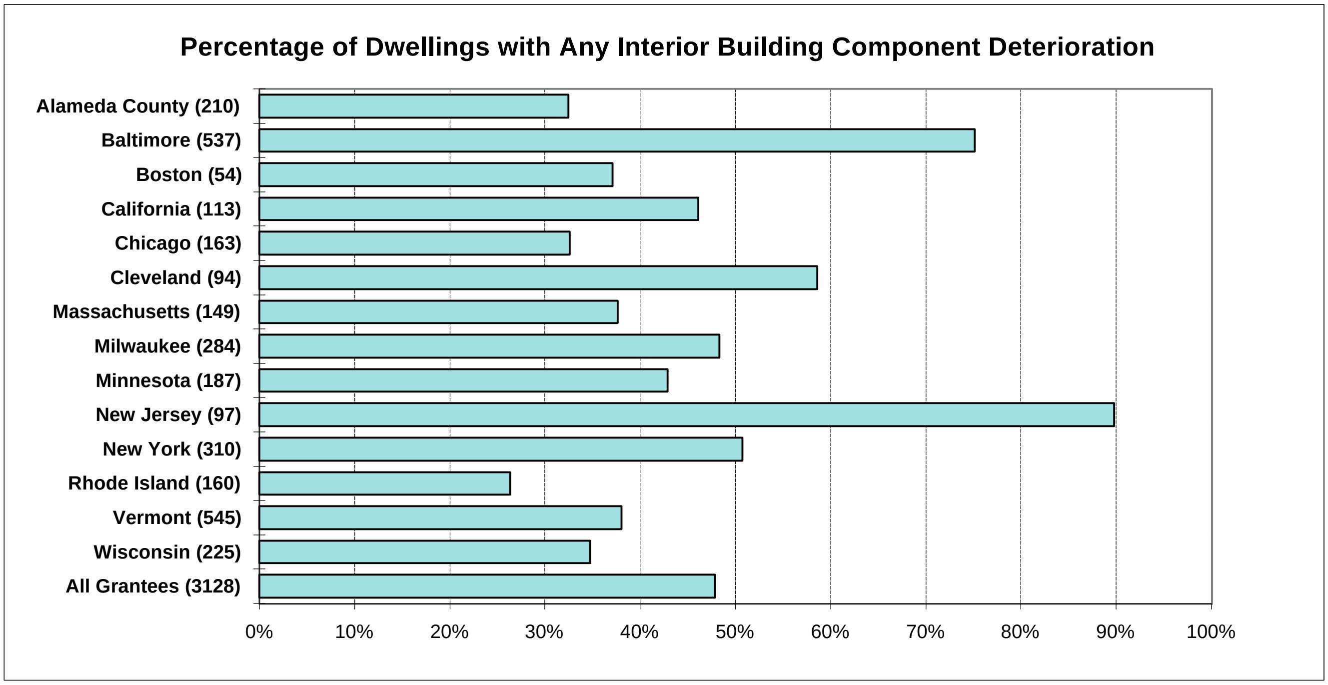
As displayed above, some of the key characteristics of buildings and dwelling units vary greatly by grantee. These variations reflect both the regional differences in housing style and the differences in the grantees' specific enrollment plans. (**Exhibit 9** offers a brief overview of six typical dwelling units that have been enrolled and treated in the Evaluation.) Such variation may affect baseline paint lead, dust lead, and soil lead levels (see the Appendix tables) and may contribute or interfere with the effectiveness of certain treatments. Because the baseline conditions for each grantee generally differ from the other grantees, this report will often discuss observed differences between grantees and the possible causes for the differences.

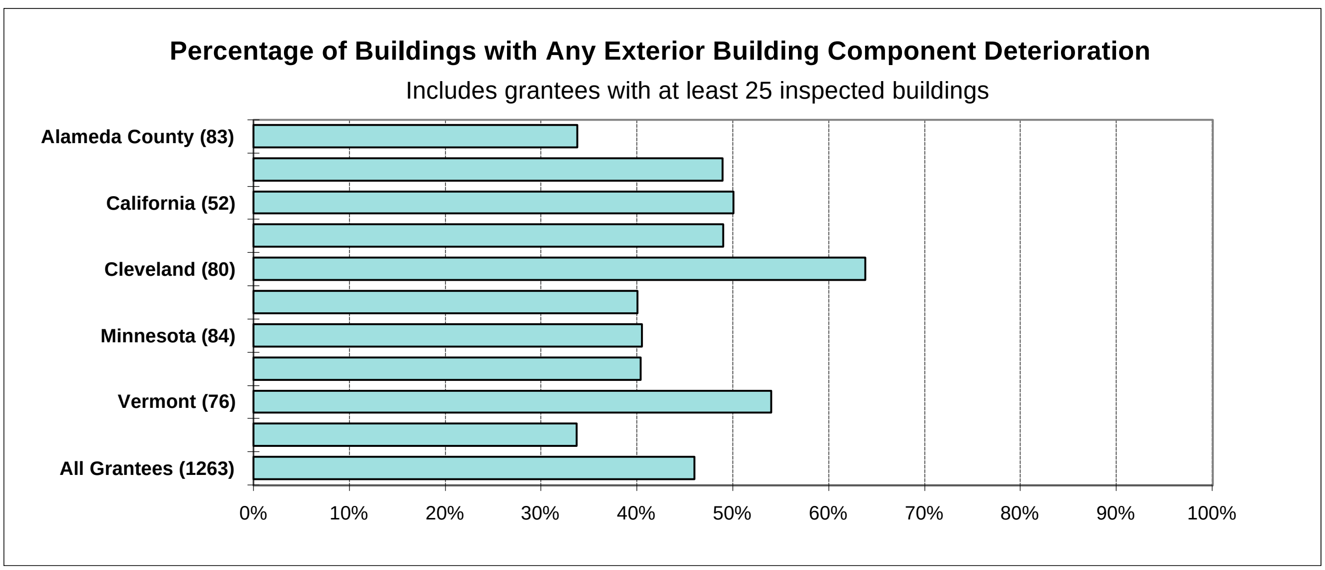
Exhibit 7: Number and Percentage of Dwelling Units by Occupancy Status and by Grantee



Note: 34 Dwelling Units with Occupancy and Ownership Status Reported as 'Other' Excluded
Data from: Form 01 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Table 11

Exhibit 8: Percentage of Inspected Dwelling Units and Buildings with Reported Building Component Deterioration by Grantee

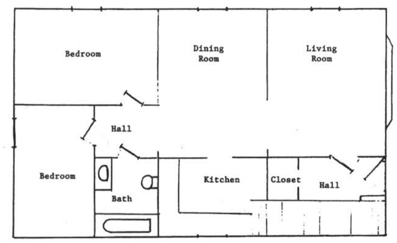




Note: Total number of inspected dwelling units or buildings in parentheses
Data from: Form 10 (Phase 01) and Form 11 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Tables 66-E and 67-B

EXHIBIT 9
EXAMPLES OF COMMONLY TREATED HOUSING - page 1 of 3

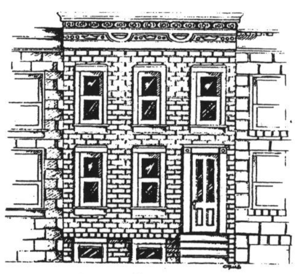
TYPICAL #3 TWO FLAT
(146 DWELLINGS)

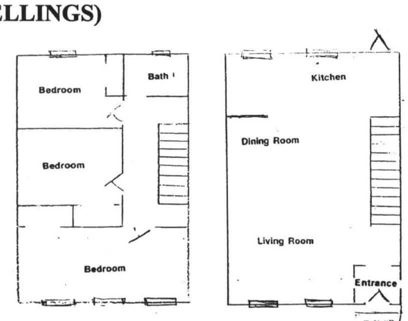


Defining Characteristics
- Pre-1920
- Non-masonry exterior
- 2-3 bedrooms per unit
- Basement

Dwelling Unit Description
- 960 sq. ft. living space per unit (quartile range 800-1,100)
- $15,750 value (quartile range $9,250-$27,000)
- 64% located in Milwaukee; 18% in Minnesota; and the remainder in five other Grantee sites.

TYPICAL #2 ROWHOUSE
(121 DWELLINGS)





Defining Characteristics
- Pre-1940
- Masonry or stucco exterior
- 2 story with basement
- 2 or 3 bedrooms

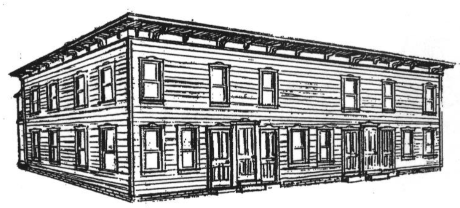
Dwelling Unit Description
- 1,030 sq. ft. living space (quartile range 847-1,138)
- $11,579 value (quartile range $9,275-$16,258)
- 95% located in Baltimore and the remainder in California and Minnesota.

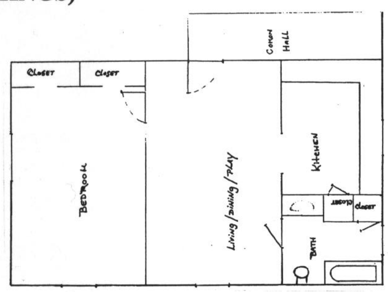
Note: Median sq. ft. living space and value reported.
Data From: Form 01, Form 10, Form 12
Data as of: September 1, 1997
Source of Data: NCLSH tables C9-C10

Typical Dwelling Unit: A dwelling unit in the appropriate building type that satisfies the defining characteristics.

EXHIBIT 9
EXAMPLES OF COMMONLY TREATED HOUSING - page 2 of 3

TYPICAL #4 SMALL MULTI
(105 DWELLINGS)

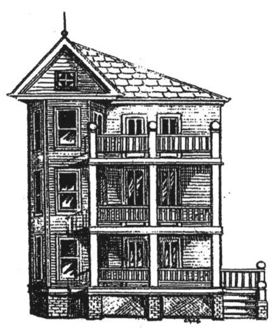


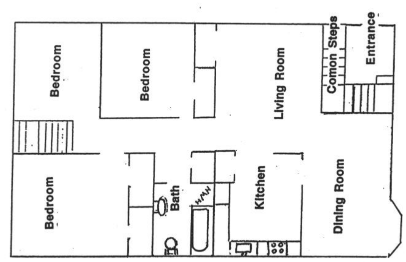


Defining Characteristics
- Pre-1910
- 5-12 Units
- 2 or 3 story with basement
- 1-3 bedrooms per unit

Dwelling Unit Description
- 700 sq. ft. living space (quartile range 600-900)
- $20,000 value (quartile range $14,700-$25,000)
- 83% located in Vermont; 10% located in Alameda County; and the remainder in three other Grantee sites.

TYPICAL #1 TRIPLEX
(82 DWELLINGS)





Defining Characteristics
- Pre-1920
- Non-masonry exterior
- 2 or 3 story
- 1-3 bedrooms per unit

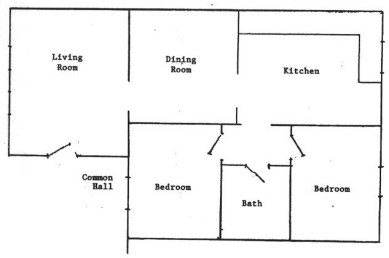
Dwelling Unit Description
- 1,000 sq. ft. living space (quartile range 750-1,300)
- $25,500 value (quartile range $20,000-$33,750)
- 42% located in Vermont; 20% in Boston; 20% in Massachusetts; and the remainder in three other Grantee sites.

Note: Median sq. ft. living space and value reported.
Data From: Form 01, Form 10, Form 12
Data as of: September 1, 1997
Source of Data: NCLSH tables C9-C10

Typical Dwelling Unit: A dwelling unit in the appropriate building type that satisfies the defining characteristics.

EXHIBIT 9
EXAMPLES OF COMMONLY TREATED HOUSING - page 3 of 3

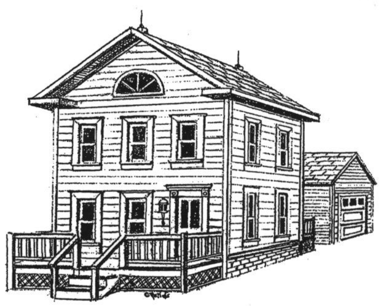
TYPICAL #6 FOURPLEX
(81 DWELLINGS)

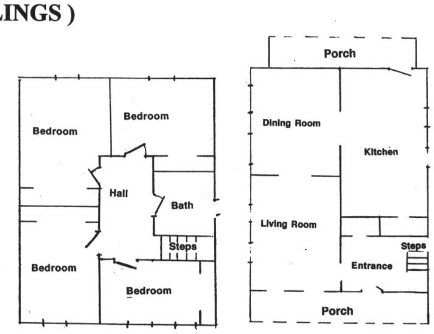


Defining Characteristics
- Pre-1950
- 1-3 bedrooms per unit
- 2 or 3 story with basement

Dwelling Unit Description
- 950 sq. ft. living space (quartile range 650-1,200)
- $20,000 value (quartile range $14,550-$26,000)
- 38% located in Vermont; 32% in Minnesota; 25% in Milwaukee; and the remainder in Boston and Rhode Island

TYPICAL #7 SINGLE
(81 DWELLINGS)





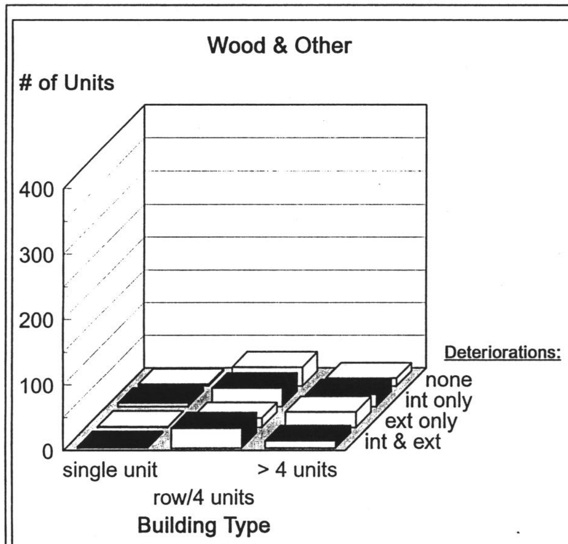
Defining Characteristics
- Pre-1920
- Wood, non-wood shingle, or aluminum siding exterior
- 3-4 bedrooms per unit
- 2 story with basement

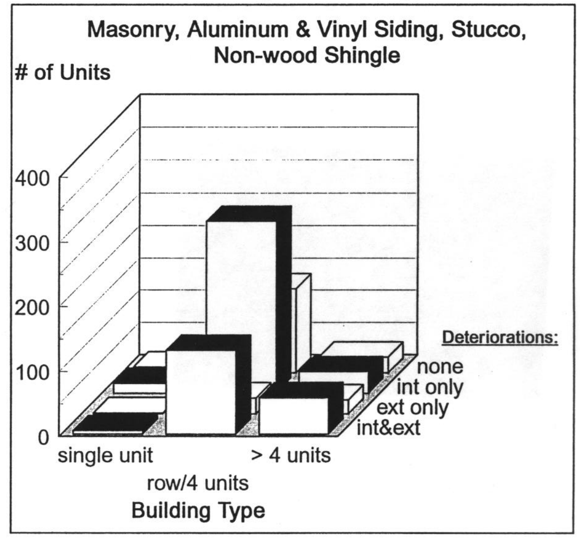
Dwelling Unit Description
- 1,500 sq. ft. living space (quartile range 1,300-2,000)
- $45,000 value (quartile range $31,500-$60,000)
- 37% located in Minnesota; 24% in Vermont; 16% in Milwaukee; 10% in Wisconsin; and the remainder in five other Grantee sites.

Note: Median sq. ft. living space and value reported.
Data From: Form 01, Form 10, Form 12
Data as of: September 1, 1997
Source of Data: NCLSH tables C9-C10

Typical Dwelling Unit: A dwelling unit in the appropriate building type that satisfies the defining characteristics.

Exhibit 10: Distribution of Units by Type of Primary Exterior, Occupancy Status, Building Type, and Presence of Deterioration (Interior & Exterior) (Page 1 of 2)



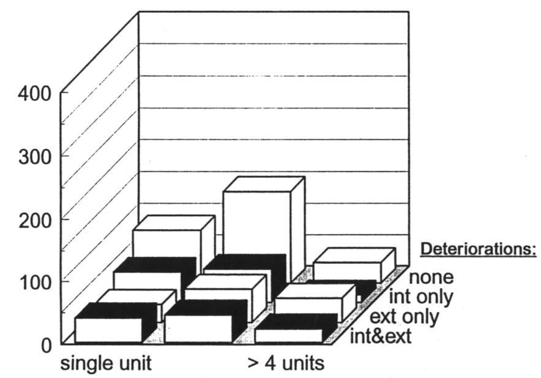


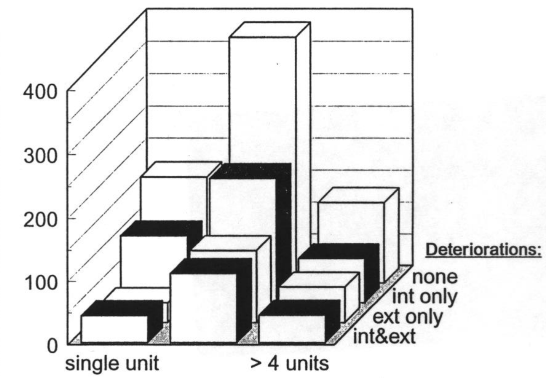
Vacant

Single Unit:	Single Detached Buildings.	none: :	No deteriorations were noted.
Row/4 Units:	Rowhouses and buildings with up to and including 4 units.	int only :	Only interior deteriorations noted.
> 4 Units:	Buildings with more than 4 units.	ext only :	Only exterior deterioratons noted.
		int & ext:	Both interior and exterior deteriorations noted.

Data from: Forms 01, 10, 11
Data as of: September 1, 1997
Source of Data: UC Figure C-1

Exhibit 10: Distribution of Units by Type of Primary Exterior, Occupancy Status, Building Type, and Presence of Deterioration (Interior & Exterior) (Page 2 of 2)





Occupied

Single Unit:	Single Detached Buildings.	none: :	No deteriorations were noted.
Row/4 Units:	Rowhouses and buildings with up to and including 4 units.	int only :	Only interior deteriorations noted.
> 4 Units:	Buildings with more than 4 units.	ext only :	Only exterior deterioratons noted.
		int & ext:	Both interior and exterior deteriorations noted.

Data from: Forms 01, 10, 11
Data as of: September 1, 1997
Source of Data: UC Figure C-1

The characteristics of the population of enrolled dwellings could also place limitations on conclusions that can be drawn from the Evaluation in general. For example, it is unlikely that any conclusions can be drawn about dwellings built after 1960, because only a small percentage the enrolled buildings were built after that date. To describe the dwellings enrolled, **Exhibit 10** was created to display the frequency of dwellings that have been enrolled with certain characteristics. The figure includes the presence or absence of any significant building deterioration, building type and occupancy status, as well as a fourth variable, type of exterior surface. Some dwellings, such as vacant, single detached units, have been rarely enrolled, while the Evaluation will have a large amount of data from occupied, small multifamily (or single attached) dwellings with no significant building deterioration.

II. Intervention Descriptions

A main attribute of the Evaluation is the flexibility that grantees have to select the lead treatments for any particular unit. The grantees have the freedom to treat all areas of the property or to treat only some locations (interior, exterior, and/or soil). The grantees also decide on the intensity of the treatments. Possible treatment intensities range from cleaning with some spot painting to partial abatement to full abatement. The grantees have been encouraged to experiment with different levels of lead hazard control activities.

Grantees are allowed to experiment because there is no consensus on a single state of the art intervention to control lead-based paint hazards. For example, some programs believe that windows containing lead-based paint must be replaced to protect the health of residents. Other programs contend that by using lower level/lower cost treatments, more residents can be served, while still protecting their health. Grantees have even decided to leave some lead-based paint hazards untreated, under the assumption that these hazards have no or limited immediate impact on the resident's health.

The Evaluation collects information about the lead interventions on two levels: a general characterization of the intensity of the intervention for each dwelling unit and a detailed list of all lead hazard control treatments. For this report, most intervention information is examined at the dwelling unit level. As more detailed treatment information becomes available, it will be discussed in future reports.

Intervention Strategies

Grantees report the intensity of the intervention as a three-part "strategy code": one strategy code for each location (interior, exterior, site). Higher strategy levels reflect more intensive treatments. The strategies are summarized on **Exhibit 11**.

As will be displayed later in this report, the strategies can be used to compare the costs and effectiveness of different interventions at the dwelling unit/building level. In order to make these comparisons, the Evaluation relied on the grantees to select different types and levels of interventions. With over half of the data about strategies submitted, grantees, as a whole, have selected a diversity of strategies. On an individual basis, however, most grantees have tended to select one or two dominant strategies. Grantees often developed one or two intervention designs that they repeated throughout the project. Some grantees had their choices of strategies

Exhibit 11: Strategy Code Definitions

Strategy		Definition
Interior	01	No Action
	02	Cleaning, Spot Paint Stabilization Only
	03	Level 02 plus Complete Paint Stabilization, Floor Treatments
	04	Level 03 plus Window Treatments
	05	Level 04 plus Window Replacement, Wall Enclosure/Encapsulation
	06	All Lead-Based Paint Enclosed, Encapsulated, or Removed (Meets Public Housing Abatement Standards)
	07	All Lead-Based Paint Removed
Exterior	00	No Action
	01	Spot or Partial Paint Stabilization
	02	Complete Paint Stabilization, Porch Treatments
	03	Level 02 plus Porch/Trim Enclosure, Stabilization or Encapsulation
	04	All Lead-Based Paint Enclosed, Encapsulated, or Removed
	05	All Lead-Based Paint Removed
Site	0	No Action
	1	Cover Soil with Temporary Cover (Mulch, Stone)
	2	Level 01 plus Seed, Install Barriers (Bushes, Fencing)
	3	Level 02 plus Partial Soil Removal, Plant Sod
	4	Complete Soil Removal or Enclosure with Asphalt, Concrete

Glossary of Treatments

Encapsulation - The application of a covering or coating that acts as a barrier between lead-based paint and the environment, the durability of which relies on adhesion and which has an expected life of at least 20 years.

Enclosure - The application of rigid, durable construction materials that are mechanically fastened to the substrate to act as a barrier between lead-based paint and the environment.

Paint Stabilization - The process of repainting surfaces coated with lead-based paint, that includes the proper removal of deteriorated paint and priming.

Paint Removal - The complete removal of lead-based paint by wet scraping, chemical stripping, or contained abrasives.

Removal/Replacement - The removal/replacement of a building component that was coated with lead-based paint.

Window Treatments - The process of eliminating lead-containing surfaces on windows that are subject to friction or impact through the removal of paint or enclosure of certain window components.

limited by the pre-intervention conditions of their housing stock and the availability of additional funding sources. For a few grantees, local laws and ordinances dictated the strategy selection.

Interior Strategies

Information on interior strategies was available for 1,506 dwelling units at the time of this report **(Exhibit 12)**. The grantees categorized 96 percent of their dwellings into one of four interior strategy levels (levels 02-05). These strategy levels represent interventions ranging from minimal spot painting and cleaning of lead-contaminated dust (level 02) up to partial abatement, including window replacement (level 05). In 69 percent of the dwellings, grantees selected interior interventions that included partial or complete replacement of windows (levels 04-05). Grantees conducted no interior work (level 01) in less than three percent of the dwellings, while full abatement of the lead hazards (levels 06-07) was performed in less than two percent of the units.

Grantee specific information is provided for the 11 grantees that submitted intervention data for at least 25 units. For 7 of the 11 grantees, over half of the units were treated with the same strategy. Six grantees tended to conduct window replacement interventions (level 05) in a majority of their units. At the seventh grantee site, Vermont selected interim controls with some significant friction controls performed on the windows (level 04) as its dominant intervention.

Milwaukee[1], and to a lesser extent Alameda County, California and Minnesota, reported a more diverse selection of interior interventions. Alameda County, Milwaukee, and Minnesota, along with Vermont were also more likely than other grantees to select the lowest level of interior intervention: cleaning with possibly some paint stabilization (Level 02). Alameda County also enrolled the majority of the units, 31 of 36, where no interior work was conducted in the dwelling.

Exterior Strategies

Grantees provided information about exterior strategies for 810 buildings **(Exhibit 13)**. Grantees have primarily selected one of two exterior interventions: partial or complete paint stabilization of lead-based paint (exterior levels 01-02). In nine percent of the units, grantees abated all lead-based paint on the exterior (levels 04-05). For 16 percent of the buildings, no exterior lead hazard control work was performed. The lack of exterior lead work may reflect a lack of lead-based paint hazards or a decision to selectively treat them. The number of buildings without exterior treatment is dominated (80%) by two grantees: Milwaukee and Minnesota.

Like interior strategies, one exterior strategy often dominated a grantee's interventions. Boston tended to conduct partial abatement of exterior/porches (level 03), while Baltimore, Massachusetts, and Vermont performed complete paint stabilization (level 02) on over half of their buildings. A few grantees, however, did select a wider range of exterior intervention. In

[1] Milwaukee (and Wisconsin) received approval to use their own interior coding system to describe its interventions. The Evaluation reclassified these codes into the standard strategy coding system using Milwaukee's definitions.

Exhibit 12: Number and Percentage of Dwelling Units in which a Specific Interior Intervention Strategy was Undertaken

(Grantee specific data shown when at least 25 dwelling units submitted)

Grantee	Interior Intervention Strategy							
	01	02	03	04	05	06	07	Total Dwellings with Strategy Reported
County	31	93	21	23	16	2	5	191
	16.2%	*48.7%*	*11.0%*	*12.0%*	*8.4%*	*1.0%*	*2.6%*	*100%*
Baltimore	0	1	4	57	105	0	0	167
	0.0%	*0.6%*	*2.4%*	*34.1%*	*62.9%*	*0.0%*	*0.0%*	*100%*
Boston	0	0	2	7	44	12	0	65
	0.0%	*0.0%*	*3.1%*	*10.8%*	*67.7%*	*18.5%*	*0.0%*	*100%*
California	0	2	12	32	27	0	0	73
	0.0%	*2.7%*	*16.4%*	*43.8%*	*37.0%*	*0.0%*	*0.0%*	*100%*
Massachusetts	0	6	4	8	95	0	0	113
	0.0%	*5.3%*	*3.5%*	*7.1%*	*84.1%*	*0.0%*	*0.0%*	*100%*
Milwaukee	0	65	67	88	15	0	0	235
	0.0%	*27.7%*	*28.5%*	*37.4%*	*6.4%*	*0.0%*	*0.0%*	*100%*
Minnesota	3	35	8	46	86	0	0	178
	1.7%	*19.7%*	*4.5%*	*25.8%*	*48.3%*	*0.0%*	*0.0%*	*100%*
New York City	0	0	0	0	72	0	0	72
	0.0%	*0.0%*	*0.0%*	*0.0%*	*100.0%*	*0.0%*	*0.0%*	*100%*
Rhode Island	0	1	5	16	32	2	0	56
	0.0%	*1.8%*	*8.9%*	*28.6%*	*57.1%*	*3.6%*	*0.0%*	*100%*
Vermont	2	63	11	167	69	0	0	312
	0.6%	*20.2%*	*3.5%*	*53.5%*	*22.1%*	*0.0%*	*0.0%*	*100%*
Wisconsin	0	2	1	7	27	0	1	38
	0.0%	*5.3%*	*2.6%*	*18.4%*	*71.1%*	*0.0%*	*2.6%*	*100%*
All Grantees:	36	268	135	452	593	16	6	1506
	2.4%	*17.8%*	*9.0%*	*30.0%*	*39.4%*	*1.1%*	*0.4%*	*100%*

Note 1: Table includes dwelling units in single and multifamily buildings. It does not include work conducted on common areas (e.g., hallways) of multifamily buildings.

Note 2: Interior Strategy Codes: 01=No Action, 02=Cleaning/Spot Painting, 03=02 + Full Painting, 04=03 + Window Treatment, 05=04 + Windows, 06=05 + Public Housing Standard, 07=Lead Free
See Exhibit 11 for detailed strategy definitions

Data from: Form 23, Question 02

Data as of: September 1, 1997

Source of Data: UC Table 176

Exhibit 13: Number and Percentage of Building Exteriors on which a Specific Exterior Intervention was Undertaken

(Grantees included if included in Exhibit 12)

Grantee	Exterior Intervention Strategy						
	00	01	02	03	04	05	Total Buildings with Strategy Reported
Alameda County	6	21	47	17	8	1	100
	6.0%	*21.0%*	*47.0%*	*17.0%*	*8.0%*	*1.0%*	*100.0%*
Baltimore	2	60	99	0	0	1	162
	1.2%	*37.0%*	*61.1%*	*0.0%*	*0.0%*	*0.6%*	*100.0%*
Boston	0	5	7	22	2	8	44
	0.0%	*11.4%*	*15.9%*	*50.0%*	*4.5%*	*18.2%*	*100.0%*
California	2	2	15	14	5	0	38
	5.3%	*5.3%*	*39.5%*	*36.8%*	*13.2%*	*0.0%*	*100.0%*
Massachusetts	0	7	32	19	2	1	61
	0.0%	*11.5%*	*52.5%*	*31.1%*	*3.3%*	*1.6%*	*100.0%*
Milwaukee	47	24	47	14	17	1	150
	31.3%	*16.0%*	*31.3%*	*9.3%*	*11.3%*	*0.7%*	*100.0%*
Minnesota	56	22	15	16	6	6	121
	46.3%	*18.2%*	*12.4%*	*13.2%*	*5.0%*	*5.0%*	*100.0%*
New York City	0	0	0	0	0	0	0
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Rhode Island	0	2	8	2	6	0	18
	0.0%	*11.1%*	*44.4%*	*11.1%*	*33.3%*	*0.0%*	*100.0%*
Vermont	12	12	51	8	8	0	91
	13.2%	*13.2%*	*56.0%*	*8.8%*	*8.8%*	*0.0%*	*100.0%*
Wisconsin	3	2	6	7	3	0	21
	14.3%	*9.5%*	*28.6%*	*33.3%*	*14.3%*	*0.0%*	*100.0%*
All Grantees:	129	160	327	119	57	18	810
	15.9%	*19.8%*	*40.4%*	*14.7%*	*7.0%*	*2.2%*	*100.0%*

Note 1: Table includes exteriors of single and multifamily buildings.

Note 2: Exterior Strategy Codes: 00=No Action, 01=Partial Paint Stabilization, 02=Complete Paint Stabilization, Porch Treatments, 03=02 + Porch/Trim Enclosure and Stabilization, 04=All Lead Paint Enclosed or Removed, 05=All Lead Paint Removed. See Exhibit 11 for detailed strategy definitions.

Data from: Form 23, Question 02

Data as of: September 1, 1997

Source of Data: UC Table 177

Exhibit 14: Number and Percentage of Buildings at which a Specific Site Intervention Strategy was Undertaken

(Grantees included if included in Exhibit 12)

Grantee	Site Strategy					
	00	**01**	**02**	**03**	**04**	**Total Buildings with Strategy Reported**
Alameda County	46	24	9	10	11	100
	46.0%	*24.0%*	*9.0%*	*10.0%*	*11.0%*	*100%*
Baltimore	162	0	0	0	0	162
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100%*
Boston	35	0	0	0	0	35
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100%*
California	28	1	0	0	7	36
	77.8%	*2.8%*	*0.0%*	*0.0%*	*19.4%*	*100%*
Massachusetts	60	0	0	0	0	60
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100%*
Milwaukee	150	0	0	0	0	150
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100%*
Minnesota	96	13	3	1	2	115
	83.5%	*11.3%*	*2.6%*	*0.9%*	*1.7%*	*100%*
New York City	0	0	0	0	0	0
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0%*
Rhode Island	5	8	4	0	0	17
	29.4%	*47.1%*	*23.5%*	*0.0%*	*0.0%*	*100%*
Vermont	79	6	1	1	0	87
	90.8%	*6.9%*	*1.1%*	*1.1%*	*0.0%*	*100%*
Wisconsin	21	0	0	0	0	21
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100%*
All Grantees:	686	52	17	12	20	787
	87.2%	*6.6%*	*2.2%*	*1.5%*	*2.5%*	*100%*

Note 1: Table includes the properties of single and multifamily buildings.

Note 2: Site Strategy Codes: 00=No Action, 01=Cover Soil, 02=01+ Seed and Install Barriers, 03=02 + Partial Soil Removal and Plant Sod, 04=Complete Soil Removal or Enclosure with Concrete. See Exhibit 11 for detailed strategy definitions.

Data from: Form 23, Question 02

Data as of: September 1, 1997

Source of Data: UC Table 178

Milwaukee and Wisconsin, one of five different exterior strategies was selected for at least nine percent of each grantee's buildings.

Out of 787 buildings with site/soil strategies reported, 686 (87%) reported no soil treatments **(Exhibit 14)**. Baltimore, Boston, Massachusetts, Milwaukee and Wisconsin reported no soil interventions at all. Only Alameda County and Rhode Island conducted soil interventions in a majority of their units. These interventions were commonly a low level strategy (a temporary soil cover such as mulch), although a small percentage of higher level treatments, including total removal, have been performed.

<u>Component System Treatments</u>

Beyond the broad picture of the dwelling unit strategies, the Evaluation has accepted detailed treatment information for 1,223 dwelling units (comprising 11,787 rooms) and 648 buildings. Like strategies, the common treatments that were conducted vary greatly by grantee. Because the vast majority of these data (71%) are reported by four grantees (Vermont, Milwaukee, Minnesota, and Alameda County), the treatments that are described are strongly influenced by these grantees.

Interior Treatments

The most common treatments that were reported (other than cleaning[2]) are window replacement and paint stabilization[3] of walls, ceilings and trim **(Exhibit 15)**. Each of these treatments has been reported in at least 25 percent of the rooms. In 20 percent of the rooms, some form of friction/impact/moisture controls were applied to the windows; seven percent of the rooms had both replacement and friction controls. Paint stabilization was also the most commonly used treatment on doors (20% of rooms), while enclosure was the preferred treatment on floors and stairways (7% of rooms).

Encapsulation was very rarely used in the 1,223 units. It was used on 13 wall/ceiling systems, two floors, and six trim systems in the 11,787 rooms. Grantees also tended to select paint stabilization or component replacement over paint removal as a treatment.

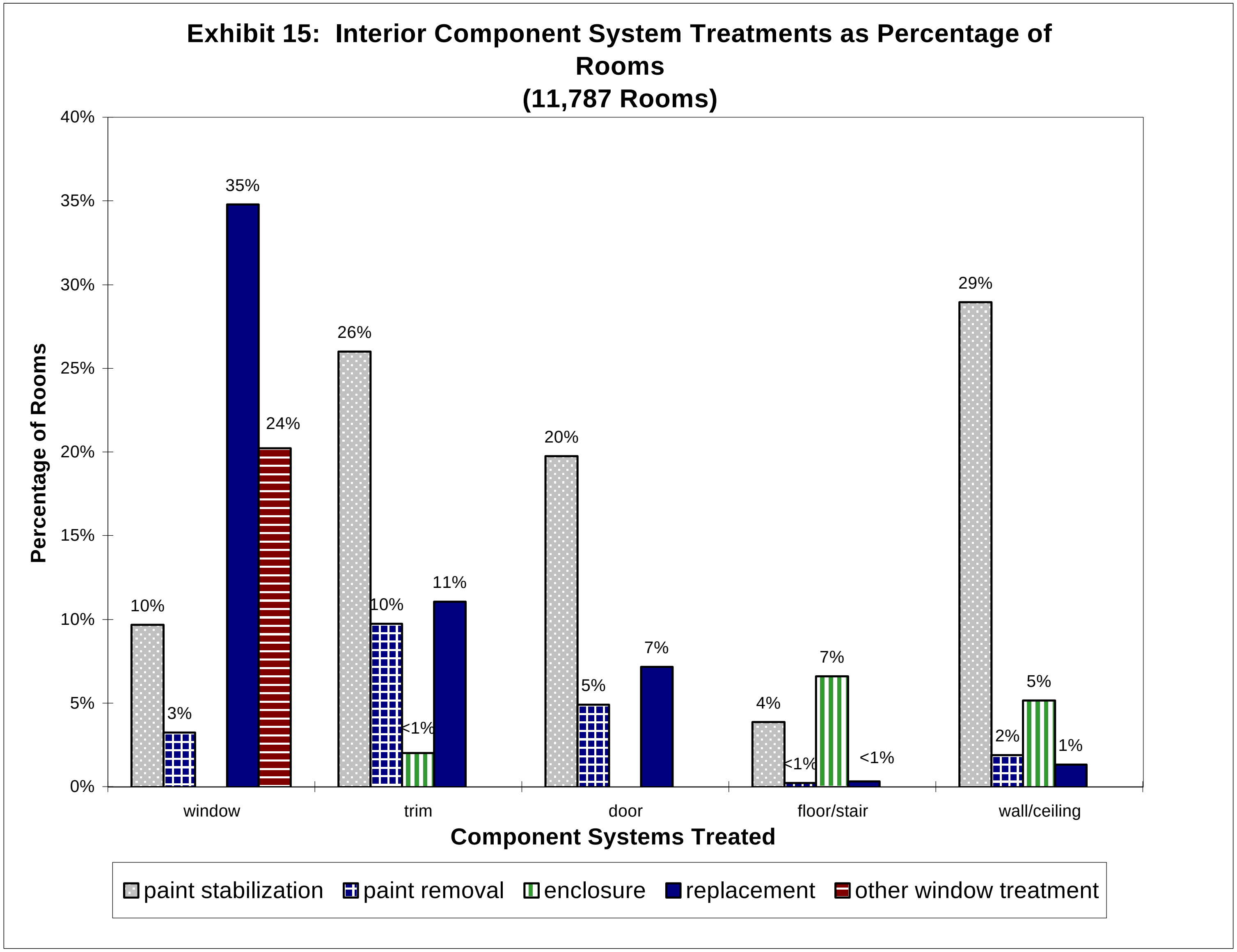
Exterior Treatments

Paint stabilization was by far the most common treatment on building exteriors, having been used on 65 percent of the buildings **(Exhibit 16).** Component replacement (18% of buildings) and enclosure (15%) were also common treatments. At 25 percent of the buildings, the paint on a porch was stabilized. Encapsulation was used five times on the exteriors of the 648 buildings. As on interiors, paint removal was a relatively infrequent choice.

For those grantees currently reporting detailed soil specifications, soil covering was the predominant choice. Even so, some type of soil covering was used at only nine percent of the buildings.

---

[2] In 82 percent of all rooms, grantees reported that lead-specific cleaning was performed before the conclusion of the intervention. No lead treatment was reported in the remaining 18 percent of rooms.
[3] Lead hazard control activities are defined at the bottom of Exhibit 11.

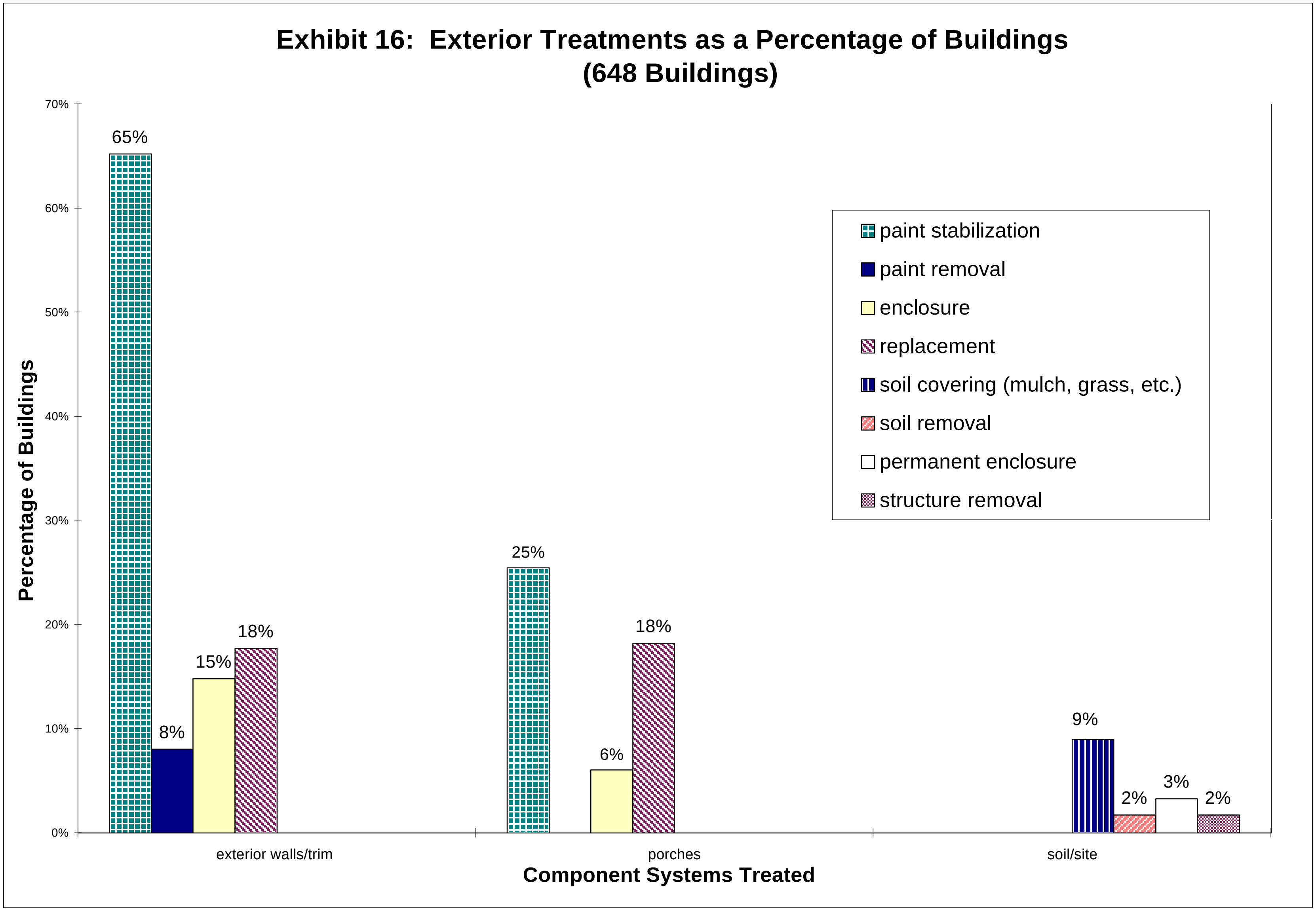


Note: Table does not include work conducted on common areas (e.g, hallways, exteriors) of multifamily buildings.

Data From: SpecMaster Export.

Data as of: September 1, 1997

Source of Data: NCLSH Table C6.



Data From: SpecMaster Export.
Data as of: September 1, 1997
Source of Data: NCLSH Table C6

Characteristics of Additional ("Concurrent") Work

Grantees reported that concurrent work (work other than lead hazard control activities) was completed somewhere on the property on 584 (39%) of 1,506 dwelling units **(Exhibit 17)**. With over one third of the dwelling units undergoing some concurrent work, analyses will have to take into account the possible effects of this extra work. Concurrent work could supplement the positive effects of lead hazard control because many of the additional activities (repainting, re-siding) are similar to the lead hazard control work. Conversely, concurrent work performed after the lead hazard control work is complete could inadvertently damage lead-based paint and create new hazards.

The decision to conduct additional work at the same time as the lead hazard control work tends to vary by grantee. Less than 25 percent of the dwelling units in Alameda County, Boston, Massachusetts, Milwaukee, and Minnesota had concurrent work performed, whereas, at least 60 percent of the units had concurrent work performed in Baltimore, Rhode Island, New York City and Wisconsin. In New York, all dwellings with treatment data submitted had concurrent work conducted.

Among the grantees that reported significant amounts of additional work, the work tended to cost $5,000 or less (weatherization or code repair). However, in Vermont over 30 percent of the dwellings had concurrent work performed that cost more than $25,000 (gut rehabilitation), while in New York City almost 70 percent of the dwellings had work conducted at this level.

Of the 584 dwelling units where concurrent work was performed, the grantees described the nature of the work for 565 dwelling units and 274 buildings. Additional painting was conducted in 85 percent of the dwelling units **(Exhibit 18)**. Moderate wall/ceiling and floor refinishing were conducted at a majority of the units. Major painting and window replacement was performed on the exteriors of 25 and 21 percent of the buildings, respectively. Depending on the lead content of the components being repainted, repaired or replaced, the concurrent work could influence the effectiveness of the lead hazard control work.

III. Intervention Costs

The Evaluation tracks the cost of lead hazard control activities reported by grantees. The lead hazard control cost is the price paid to the contractor or staff for the lead work. The cost includes worksite preparation, lead treatments, clean-up, and hazard disposal, as well as profit and overhead. Costs associated with the program, including project design, relocation, oversight, and clearance are not included.

Although the analysis of lead hazard control costs would appear to be straight-forward, it is complicated by several factors. First, lead hazard control activities may be accompanied by other housing rehabilitation work. This concurrent work may be of a similar nature to the lead work, so a somewhat arbitrary line may be drawn between the two activities and their costs. For example, when a dwelling unit is undergoing work in addition to the lead work, windows could be removed by the lead contractor, but replaced by the general contractor. Although the activity is essentially the same as if the lead contractor completed the installation, the project with concurrent work will appear to have much lower lead hazard control costs.

Exhibit 17: Number and Percentage of Dwelling Units Having Undergone Concurrent Non-Lead Work by the Nature of the Concurrent Work

(Grantee specific data shown when at least 25 dwelling units submitted)

	Nature of Concurrent Work						
Grantee	**None**	**Prerequisite Work**	**Weatherization Code Repair**	**Modererate Rehab.**	**Substantial Rehab.**	**Gut Rehab.**	**Total Dwellings with Intervention Reported**
Alameda County	161	0	20	5	1	4	191
	84.3%	*0.0%*	*10.5%*	*2.6%*	*0.5%*	*2.1%*	*100%*
Baltimore	30	51	85	1	0	0	167
	18.0%	*30.5%*	*50.9%*	*0.6%*	*0.0%*	*0.0%*	*100%*
Boston	58	0	7	0	0	0	65
	89.2%	*0.0%*	*10.8%*	*0.0%*	*0.0%*	*0.0%*	*100%*
California	41	3	26	3	0	0	73
	56.2%	*4.1%*	*35.6%*	*4.1%*	*0.0%*	*0.0%*	*100%*
Massachusetts	88	0	13	12	0	0	113
	77.9%	*0.0%*	*11.5%*	*10.6%*	*0.0%*	*0.0%*	*100%*
Milwaukee	188	9	11	8	18	1	235
	80.0%	*3.8%*	*4.7%*	*3.4%*	*7.7%*	*0.4%*	*100%*
Minnesota	169	1	1	0	4	3	178
	94.9%	*0.6%*	*0.6%*	*0.0%*	*2.2%*	*1.7%*	*100%*
New York City	0	0	0	0	22	50	72
	0.0%	*0.0%*	*0.0%*	*0.0%*	*30.6%*	*69.4%*	*100%*
Rhode Island	22	0	29	3	2	0	56
	39.3%	*0.0%*	*51.8%*	*5.4%*	*3.6%*	*0.0%*	*100%*
Vermont	144	0	0	30	42	96	312
	46.2%	*0.0%*	*0.0%*	*9.6%*	*13.5%*	*30.8%*	*100%*
Wisconsin	15	2	15	5	0	1	38
	39.5%	*5.3%*	*39.5%*	*13.2%*	*0.0%*	*2.6%*	*100%*
All Grantees:	922	66	207	67	89	155	1506
	61.2%	*4.4%*	*13.7%*	*4.4%*	*5.9%*	*10.3%*	*100%*

Note: Table includes dwelling units in single and multifamily buildings. It does not include work conducted on common areas (e.g., hallways, exteriors) of multifamily buildings.

Data from: Form 23, Question 10

Data as of: September 1, 1997

Source of Data: UC Table 182

Exhibit 18: Interior Concurrent Work Type as a Percentage of Dwellings with Concurrent Work and Exterior Concurrent Work Type as a Percentage of Buildings with Concurrent Work

Categories of Interior Concurrent Work (565 Dwelling Units)		Categories of Exterior Concurrent Work (274 Buildings)	
Repainting	481 85%	Major Repainting	68 25%
Moderate Wall/Ceiling Repair	381 67%	Window Replacement	58 21%
Floor Refinishing	323 57%	Storm Window Installation	48 18%
Carpet Installation	208 37%	Landscaping	42 15%
Major Wall/Ceiling Repair	147 26%	Siding Replacement	27 10%

Data from: Form 23, Question 09 and Questions 12-21.

Data as of: September 1, 1997.

Source of Data: UC Table 183-M and 183-S and NCLSH Table C11.

Second, the per unit cost of treating multifamily dwellings is influenced by the number of units treated in a building and the exterior/common space costs (e.g., costs for halls, stairwells, etc.). For example, in a four-unit building where dwelling unit treatments cost $1,000 each and exterior/common area treatments cost $2,000, the per unit cost to treat one unit would be $3,000, while the per unit cost to treat four units would be $1,500. Because forms for a multifamily building are not submitted at once and data are still being submitted, the per unit costs for multifamily buildings could be affected greatly by the forms available.

Third, a number of potentially important factors in determining the cost of lead hazard control are simultaneously present in dwellings undergoing lead hazard control work. Two of these factors are examined below. These factors represent the nature of the housing being addressed (type of building) and the intensity of the attempted lead hazard control (interior strategy). For simplicity of presentation, the relationship of these factors and costs are examined one variable at a time. Each of the presented relationships may be affected by the other or even other factors not yet examined. In later reports, an examination of these potential factors will be undertaken in which the impact of multiple factors will be considered.

Costs by Type of Building

The effect of these complicating factors is that the intervention costs for single-family homes are much easier to characterize. Grantees submit all interior/exterior and concurrent work costs for a single-family dwelling at the same time and every cost is allocated to that one dwelling unit. From the information reported by the grantees, the median lead hazard control costs for single-family detached housing was $8,001-10,000 (**Exhibit 19)**. Single-family attached housing (rowhouses) which tends to be smaller than the detached housing, had median lead hazard control costs of $6,001-8,000. When concurrent work is included, the median total project cost for both types of single-family dwelling units was $8,001-$10,000.

For multifamily dwelling units, one way to address the complications of missing data is to exclude exterior/common area costs and concurrent costs. Looking only at the costs of lead hazard control work on the interiors of multifamily units, the median cost for most building types is $4,001-6,000 per unit (**Exhibit 20)**. In two-unit buildings (duplexes and two-flats), the costs are lower ($2,001 to $4,000/unit). As more complete information becomes available, the Evaluation will examine the total project costs of multifamily interventions.

Costs by Strategy

Single Family Dwellings

As expected, as the intensity of the work increases so does the cost. The median lead hazard control and total project cost for units where a strategy of selective cleaning (interior level 02) was performed was $721 (**Exhibit 21**). As additional work was performed, the median lead hazard control costs jumped to $5,000 (level 03), $7,604 (level 04), and then $9,935 (level 05). At interior strategy level 05, full window replacement and component enclosure or replacement is performed. When the level of lead hazard control work increased, it also tended to be accompanied by higher levels of concurrent work. When level 03 interior work was conducted, the difference between the median lead and total project costs was $100. When grantees selected level 05 interior work, the difference between the two costs was $990.

Multifamily Dwellings

The median lead hazard control costs were generally lower in multifamily units than single family units (**Exhibit 22).** The lower costs can be explained, in part, by the exclusion of exterior costs and the smaller size of multifamily units. A preliminary effort has been made to estimate the ratio of interior to exterior costs in single family housing. Although final analyses were not yet ready for this report, it will be possible to compare single-family and multifamily interior costs and total costs in the final report.

While multifamily units had lower costs, the expected relationship between strategy level and cost was apparent. As the intensity of the intervention increased, so did the costs. The median lead hazard control cost of interventions in multifamily units ranged from $500 for interior strategy 02 to $5,544 for strategy level 05.

While the median values are a useful tool for characterizing the central tendency of intervention costs, there is often a wide range of costs associated with any given strategy **(Exhibit 23).** A single strategy can have widely different scopes of work (and different costs) based on the size of the dwelling and the number of components that are treated. Costs may also vary within a single strategy because of regional price variability. Field observations suggest that very similar work can have much different costs across the country because the local lead abatement contracting market and other local conditions that can influence prices. In addition, lead hazard control work varies from job-to-job, depending on the contractor's success at estimating the costs of labor and materials along with profits for each scope of work.

IV. Clearance of Dwelling Units

All dwellings in the HUD Lead Hazard Control Grant Program are required to "meet clearance" after the intervention is complete. In other words, dust wipe tests must be taken that demonstrate that the amount of leaded dust on components in all treated rooms do not exceed levels designated by HUD. If the amount of lead in dust on any tested component in a dwelling unit exceeds the clearance levels, recleaning and the successful retesting of the failed surface is required before reoccupancy is approved.

When the NOFAs for the first and second rounds of the HUD Lead Hazard Control Grant Program were issued, HUD had established 200, 500 and 800 $\mu g/ft^2$ (micrograms of lead/square foot tested) as the clearance level for floors, interior window sills and window troughs. Since then, HUD and EPA released new guidance that lowered the clearance level on floors.[4] HUD has allowed grantees to continue to use 200 $\mu g/ft^2$, use 100 $\mu g/ft^2$, or use a locally established level if less than 200 $\mu g/ft^2$. Five grantees used clearance levels less than 200 $\mu g/ft^2$ for floors: Cleveland, Chicago, New Jersey and New York City use 100 $\mu g/ft^2$ and Minnesota uses 80 $\mu g/ft^2$.

[4] In 1994-95, HUD and the Environmental Protection Agency (EPA) both issued guidance identifying levels at which lead in dust is a hazard. The levels are 100 $\mu g/ft^2$ for floors, 500 $\mu g/ft^2$ for window sills, and 800 $\mu g/ft^2$ for window troughs. To date, no federal health-based standards have been established for lead-in-dust.

Exhibit 19: Frequency Distribution of Total Project and Lead Hazard Control Costs for Single-Family Dwellings (Detached and Row Homes)									
Building Type		**Cost**							
		<=$2,000	**$2,001 to $4,000**	**$4,001 to $6,000**	**$6,001 to $8,000**	**$8,001 to $10,000**	**$10,001 to $20,000**	**>$20,000**	**Total Buildings**
Single family detached	**Total Project Cost**	28	21	33	33	24	90	39	268
		10.4%	*7.8%*	*12.3%*	*12.3%*	*9.0%*	*33.6%*	*14.6%*	*100.0%*
	Lead Hazard Control Work Cost	29	23	38	32	29	96	21	268
		10.8%	*8.6%*	*14.2%*	*11.9%*	*10.8%*	*35.8%*	*7.8%*	*100.0%*
Rowhouse	**Total Project Cost**	3	12	19	37	47	63	0	181
		1.7%	*6.6%*	*10.5%*	*20.4%*	*26.0%*	*34.8%*	*0.0%*	*100.0%*
	Lead Hazard Control Work Cost	3	13	27	51	47	40	0	181
		1.7%	*7.2%*	*14.9%*	*28.2%*	*26.0%*	*22.1%*	*0.0%*	*100.0%*

Note: Only includes data from forms determined to be without data entry errors.

Data from: Form 01; Form 23, Question 07.

Data as of September 1, 1997

Source of Data: UC Table 319 & 320

Exhibit 20: Frequency Distribution of Lead Hazard Control Costs for Interiors of Dwelling Units in Multifamily Dwellings								
Type of Building	**Lead Hazard Control Costs**							
	$2,000 or less	**$2,001 to $4,000**	**$4,001 to $6,000**	**$6,001 to $8,000**	**$8,001 to $10,000**	**$10,001 to $20,000**	**More than $20,000**	**Dwellings with Reported Cost Data**
Two-Family	115	**90**	58	30	21	19	2	335
	34.3%	***26.9%***	*17.3%*	*9.0%*	*6.3%*	*5.7%*	*0.6%*	*100.0%*
Triplex	35	33	**47**	44	19	12	1	191
	18.3%	*17.3%*	***24.6%***	*23.0%*	*9.9%*	*6.3%*	*0.5%*	*100.0%*
Four-plex	51	26	**34**	25	12	10	0	158
	32.3%	*16.5%*	***21.5%***	*15.8%*	*7.6%*	*6.3%*	*0.0%*	*100.0%*
More than Four Units	87	56	**110**	22	16	7	0	298
	29.2%	*18.8%*	***36.9%***	*7.4%*	*5.4%*	*2.3%*	*0.0%*	*100.0%*

Note 1: Table does not include work conducted on common areas (e.g., hallways) of multifamily buildings.

Note 2: Only includes data from forms determined to be without data entry errors.

Note 3: Median value falls within group in boldface.

Data from: Form 01; Form 23, Question 07.

Data as of September 1, 1997

Source of Data: UC Table 320

Exhibit 21: Median Lead Hazard Control Costs and Total Project Costs by Interior Intervention Strategy for Single Family Dwellings

Interior Intervention Strategy	Median Lead Hazard Control Cost	Median Total Project Cost	Number Of Dwellings
02	$721	$721	39
03	$5,000	$5,100	43
04	$7,604	$8,150	150
05	$9,935	$10,925	202

Note 1: Only includes data from forms determined to be without data entry errors.

Note 2: See Exhibit 11 for strategy definitions.

Data from: Form 23.

Data as of: September 1, 1997

Source of Data: UC Table 335-S* and 334-S*

Exhibit 22: Median Lead Hazard Control Costs by Interior Intervention Strategy for Multifamily Dwellings (Interiors Only)

Interior Intervention Strategy	Lead Hazard Control Costs	
	Median Lead Hazard Control Cost	Number Of Dwellings
02	$500	191
03	$2,122	88
04	$4,038	294
05	$5,544	384

Note 1: Only includes data from forms determined to be without data entry errors.

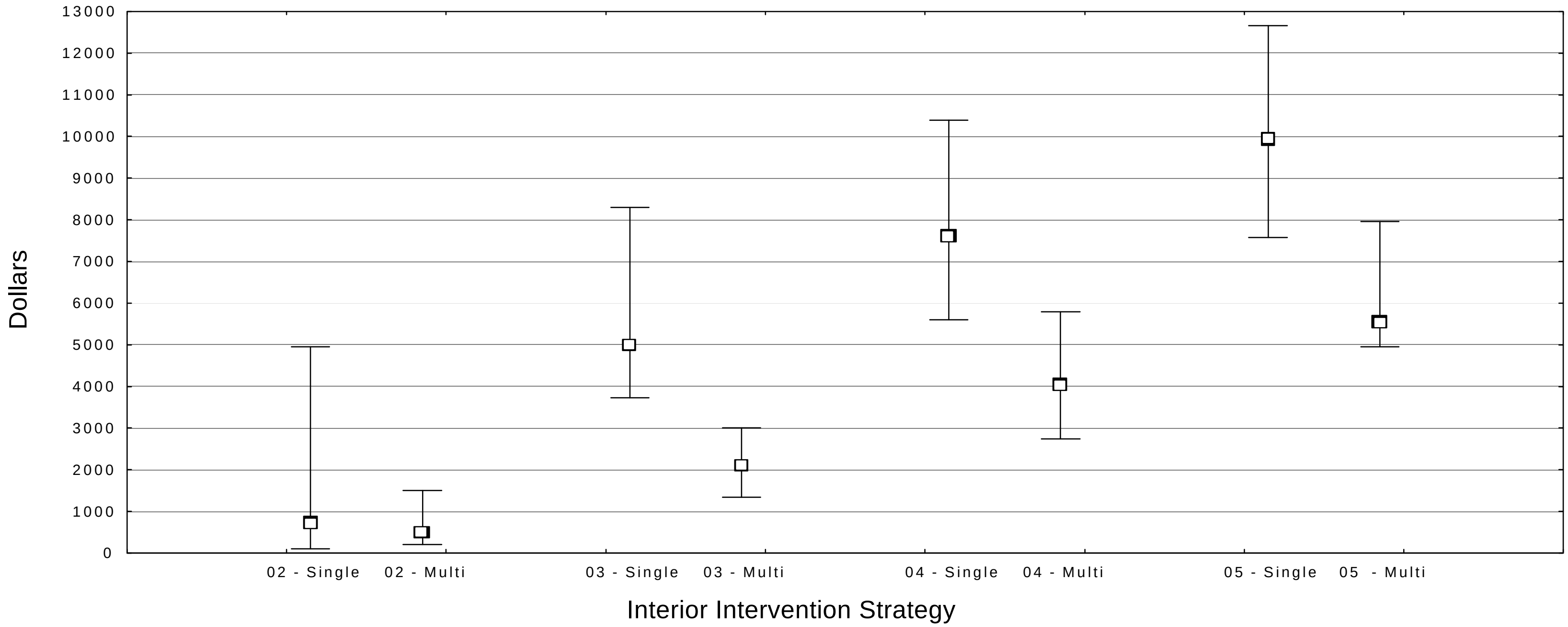
Note 2: See Exhibit 11 for strategy definitions.

Data from: Form 23.

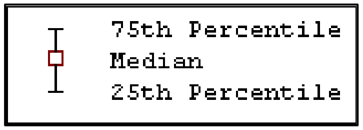
Data as of: September 1, 1997

Source of Data: UC Table 335-M*

Exhibit 23: Lead Hazard Control Costs in Single Family and Multifamily Dwelling by Interior Intervention Strategy



Note 1: Only includes data from forms determined to be without data entry errors.
Note 2: See exhibit 11 for strategy definitions.
Data From: Form 23
Data as of: September 1, 1997
Source of Data: UC Tables 335-M* and 335-S*



Numeric Values for Exhibit 23

	02 Single	02 Multi	03 Single	03 Multi	04 Single	04 Multi	05 Single	05 Multi
25th Percentile	98	212	3732	1347	5607	2740	7571	4947
Median	721	500	5000	2112	7604	4038	9935	5544
75th Percentile	4950	1500	8300	3000	10390	5790	12655	7963
Number of Dwellings	39	191	43	88	150	294	202	384

Initial Clearance Failure Rates

After lead hazard control work was completed, specialized cleaning was performed in all units in the Evaluation prior to "clearance" or post-intervention dust lead tests. The purpose of these tests is to determine if dust lead contamination present prior to the intervention, as well as contamination generated during the intervention, has been reduced to acceptable levels prior to re-occupancy of the dwelling. All dwellings with initial post-intervention dust lead levels above clearance levels must be re-cleaned and re-tested until clearance levels are achieved.

The proportion of dwellings with initial clearance "failures" is, nonetheless, an outcome of some practical significance. Re-cleaning incurs additional costs of cleaning and re-testing. The costs and inconvenience of continuing to provide alternative housing for relocated families must be considered. In addition, the prevalence of failures provides evidence of the importance of requiring dust tests to protect occupants. The data may eventually offer some information about the ability to contractors to improve their cleaning practices over time.

Of the 2,217 dwelling units for which clearance sampling data was submitted, 72 percent passed on the first attempt (**Exhibit 24**). Among the 616 units that failed to pass clearance on the first attempt, there appears to be a grantee influence. Grantees tended to fall into four categories: grantees with failure rates below 10 percent (1 grantee), grantees with failure rates of approximately 20 percent (5), grantees with failure rates between 35 and 40 percent (4), and grantees with failure rates above 40 percent (3). As will be discussed later, there appears to be some correlation between the rates of failure and the actual intervention efficiency. For example, Rhode Island which has one of the lowest failure rates also consistently reported some of the lowest dust lead levels at Phase 02 across all grantees.

Initial Failure Rates by Component

Among dwellings for which initial post-intervention clearance dust wipe test results are available, 18 percent had at least one floor location with a lead loading above the applicable grantee's clearance level (**Exhibit 25**). The initial clearance failure rate for floors was higher than that reported for window sills (8%) or for window troughs (10%). While one might expect that the grantee clearance rates on window sills to be related to grantee clearance rates on window troughs, this does not appear to be true. Alameda County, California, Chicago, and Massachusetts had approximately twice the percentage of window sill failures as trough failures, while Baltimore, Boston and New York had the reverse condition. The other grantees did have similar failure rates on interior window sills and window troughs.

V. Changes in Dust Lead Loading

A key measure of the effectiveness of lead hazard control activities is the extent to which these activities produce sustained reductions in dust lead loading. The Evaluation will examine changes in dust lead levels over several intervals. It will examine the initial change in dust lead loading from pre-intervention (Phase 01) to immediate post-intervention (Phase 02). The Evaluation will also measure the change from post-intervention (Phase 02) to six months (Phases 03) and one year (Phase 04). (For a subset of the dwelling units in the Evaluation, the changes in dust lead loadings will be measured for two and three years (Phase 05-06)).

Exhibit 24: Number and Percentage of Dwellings with Initial Post-Intervention Dust Lead Loadings Above Grantee Clearance Levels (Initial Clearance Failures)

(Grantee specific data shown when at least 25 dwelling units submitted)

Grantee	Number of of dwellings tested	Initial clearance failures (%)
Alameda County	126	37%
Baltimore	375	19%
Boston	66	36%
California	98	20%
Chicago	67	39%
Cleveland	64	50%
Massachusetts	135	39%
Milwaukee	249	43%
Minnesota	183	48%
New York City	207	19%
Rhode Island	131	8%
Vermont	371	20%
Wisconsin	126	20%
All Grantees	2217	28%

Note 1: A single failure of either a floor, window sill, or window trough wipe constitutes a dwelling unit failure on this table.

Note 2: Occupancy is based on status at Phase 02.

Note 3: Clearance levels are Grantee specific.

Data from: Form 19.

Data as of: September 1, 1997

Source of Data: UC Table 80A.

Exhibit 25: Number and Percentage of Dwellings with Initial Post-Intervention Dust Lead Loadings on Floors, Sills, and Troughs Above Grantee Clearance Levels (Initial Clearance Failures)

(Grantee specific data shown when at least 25 dwelling units submitted)

Grantee	Floor		Window Sill		Window Trough	
	Number of dwellings tested	Initial clearance failures (%)	Number of dwellings tested	Initial clearance failures (%)	Number of dwellings tested	Initial clearance failures (%)
Alameda County	115	17%	114	19%	78	9%
Baltimore	349	13%	348	2%	344	6%
Boston	65	31%	65	6%	65	12%
California	94	14%	83	7%	37	3%
Chicago	63	29%	62	10%	59	5%
Cleveland	63	41%	63	16%	53	17%
Massachusetts	133	32%	133	11%	131	6%
Milwaukee	236	19%	238	18%	235	20%
Minnesota	183	33%	181	12%	172	19%
New York City	148	12%	142	4%	131	10%
Rhode Island	130	6%	129	2%	129	2%
Vermont	307	13%	306	6%	269	8%
Wisconsin	123	10%	120	6%	116	8%
All Grantees	2028	18%	2001	8%	1831	10%

*A single failure of a floor, window sill, or window trough wipe constitutes a dwelling unit failure for that component on this table.

Note 1: Clearance levels are Grantee specific.

Data from: Form 19.

Data as of: September 1, 1997.

Source of Data: UC Table 081 & 082.

The change in dust levels between Phase 01 and 02 may reflect the effectiveness of the lead hazard control activities to: minimize the generation of leaded dust during the lead paint hazard control work, contain dust and debris that is generated, make floors smooth and cleanable, and clean up pre-existing dust lead contamination as well as any contamination resulting from the intervention. Changes in dust lead loading from Phases 02 through 04 and beyond may reflect the effectiveness of lead hazard control activities to minimize the generation of leaded dust from deterioration, friction, or impact of lead painted surfaces, and make surfaces smooth and cleanable. In addition, reaccumulation of leaded dust in dwellings may reflect recontamination by leaded soil or dust tracked in or blown in from outside of the dwelling unit.

Potential Effects of Laboratory Reporting Limits

Laboratories utilized by grantees for dust lead analysis did not use the same "limit of detection" to report results. Some laboratories did not report a discrete number below 25 micrograms (μg) while other labs reported results as low as 2 μg. For this report, each result that is below the limit of detection is analyzed using a value of one divided by the square root of two multiplied by the reported value. As a result, the distribution of measured dust lead loading values is truncated on the low end at different levels for the various grantees. Consequently, the effects that interventions may have on dwellings with low baseline dust lead levels will be obscured for some grantees.

Because values at the limit of detection are converted to the surrogate value for analysis, "real" values that are low are indistinguishable from calculated values. For example on Exhibit 24, the median floor dust value for Vermont at all three phases is 21 $\mu g/ft^2$. Because Vermont's effective reporting limit on floors[5] is generally 30 $\mu g/ft^2$, these results are all most likely at the limit of detection. Without more information from the laboratories, it is impossible to determine whether the true dust lead levels actually declined or increased across the three phases. In all likelihood, the true values were not constantly 21 $\mu g/ft^2$. The percentage of samples below the limit of detection for a particular component and phase is included at the bottom of Exhibits 28-30. The Evaluation quality control officer is working with the environmental labs to refine the dust lead data that are available for analysis. Details of this effort are described at the end of the Quality Control section of this report, p. 111.

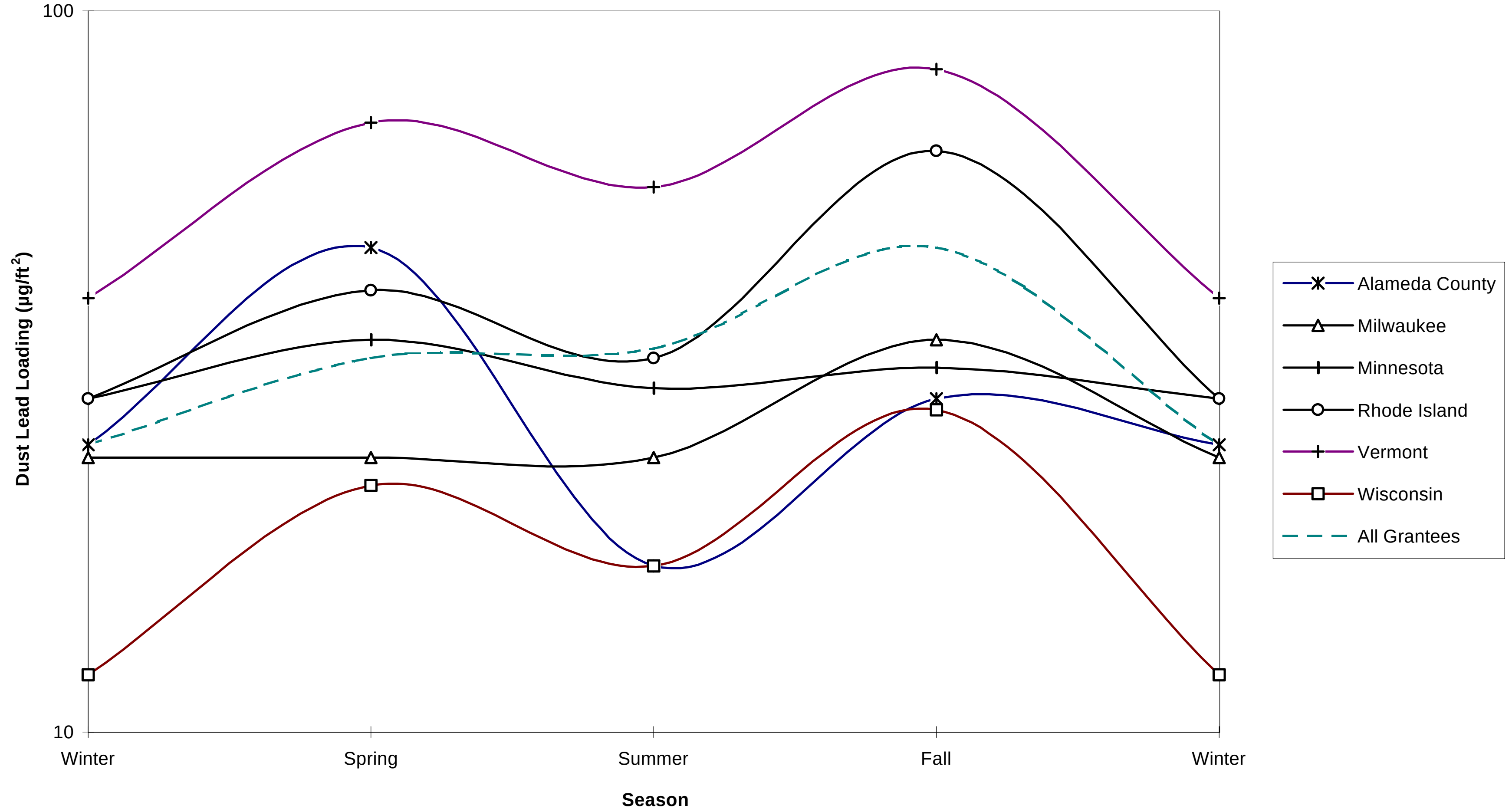
Seasonal Trends

Although it is premature to arrive at any conclusions over trends of lead in dust by season, some possible trends are beginning to emerge. Six grantees collected baseline floor dust wipe samples from at least 25 occupied dwelling units in all four quarters of the year (January-March, April-June, July-September, and October-December) (**Exhibit 26**). Among these six grantees, a visually determined pattern in levels is apparent. The highest geometric mean floor dust lead levels were found in the fall (October-December), while the lowest levels occurred in the winter (January-March). The geometric mean floor dust lead loadings declined from the second quarter (spring) to the third (summer) and from the fourth (fall) to the first quarter

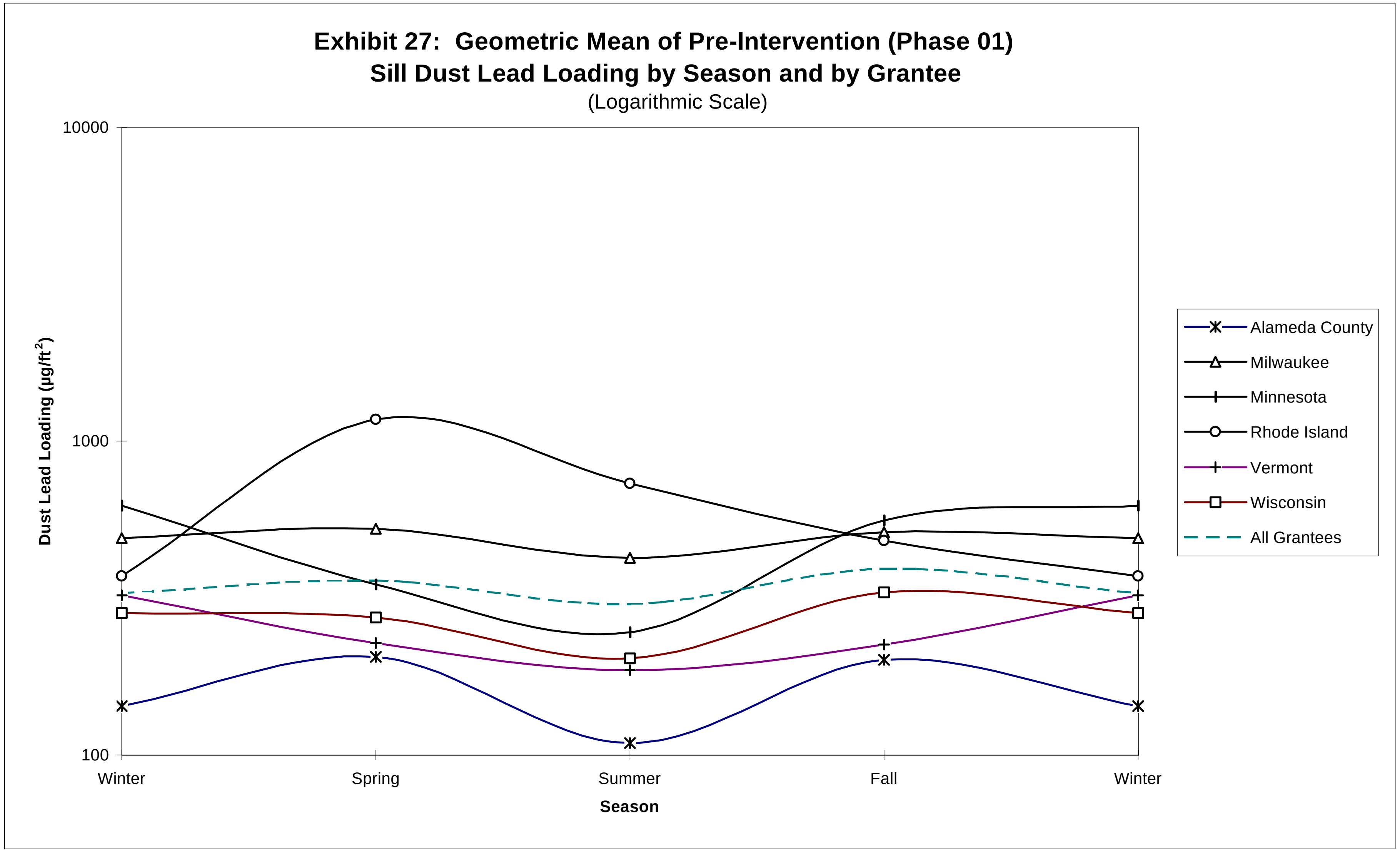
[5] Vermont's lab has a detection limit of 10 μg, which when combined with the .34 ft^2 (7"x7") templates that Vermont uses, results in a detection limit of 30 $\mu g/ft^2$.

Exhibit 26: Geometric Mean of Pre-Intervention (Phase 01) Floor Dust Lead Loading by Season and by Grantee

(Logarithmic Scale)



Note: Graph presents smoothed lines generated in Microsoft Excel
Data from: Form 19 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Table 27E



Note: Graph presents smoothed lines generated in Microsoft Excel
Data from: Form 19 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Table 33E

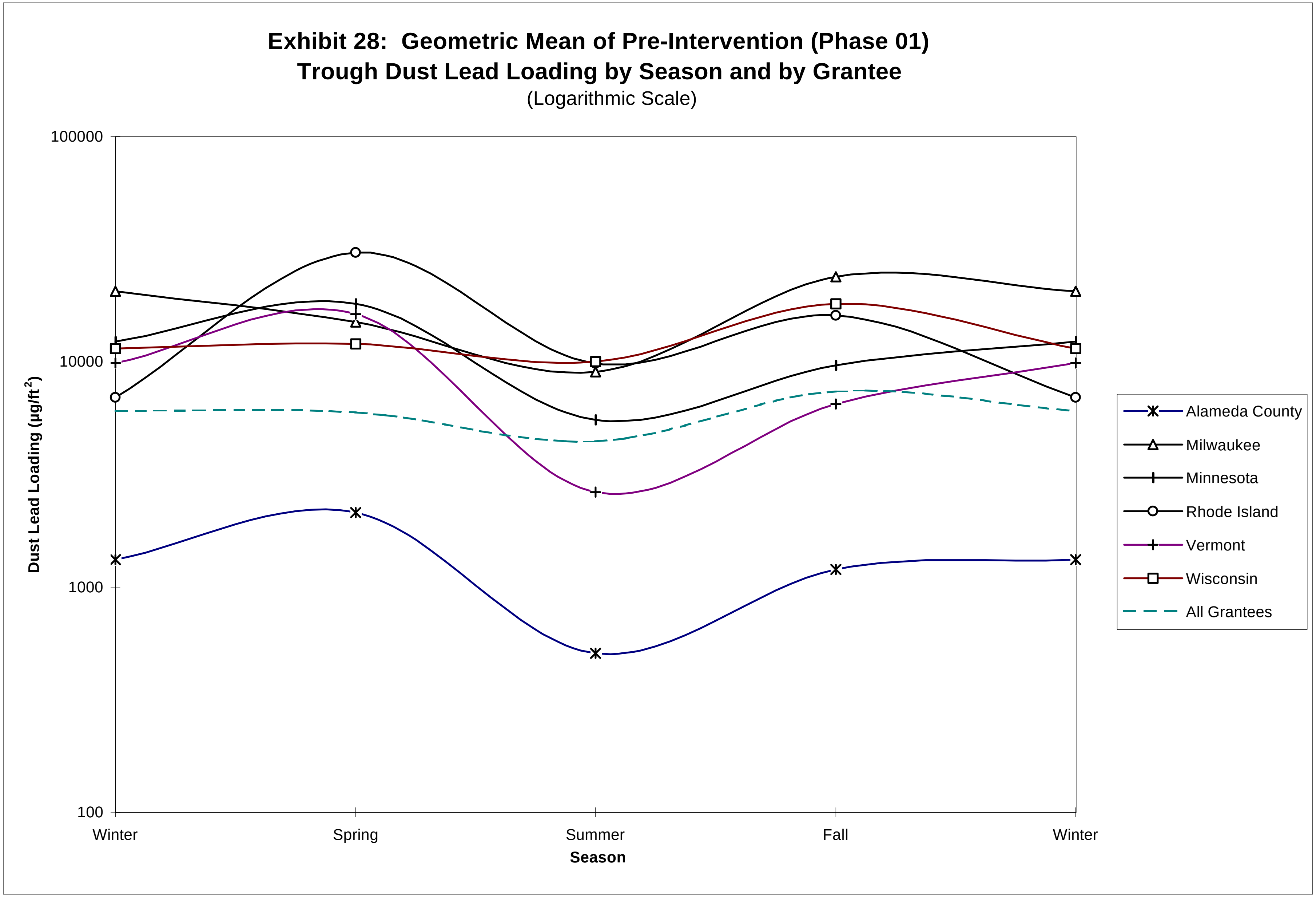


Exhibit 28: Geometric Mean of Pre-Intervention (Phase 01)
Trough Dust Lead Loading by Season and by Grantee
(Logarithmic Scale)
100000
10000
1000
100
Dust Lead Loading (µg/ft²)
Winter
Spring
Summer
Fall
Winter
Season
Alameda County
Milwaukee
Minnesota
Rhode Island
Vermont
Wisconsin
All Grantees

(winter), while they increased between winter and spring and the summer and fall. For an as yet undetermined reason, dust lead levels in Milwaukee are an exception to this pattern.

On interior window sills and window troughs (**Exhibit 27 and 28**), a similar but less pronounced pattern exists. For all grantees except Milwaukee and for all grantees combined, the lowest geometric mean sill and trough dust lead levels were collected in the summer. Geometric mean window lead levels tended to decline from the spring to the summer and then increase in the fall. Between the fall and the spring, changes in dust lead levels were not as consistent.

For each sampling location, the seasonal fluctuations are dampened when data from all grantees are combined. The determination that a true seasonal pattern exists awaits further data, followed by tests of statistical significance. Until further research is conducted, the possible influence of natural changes in the environment on dust lead reaccumulation should be considered.

<u>Effect of Occupancy Status</u>

Previous analyses of the Evaluation data have shown that dwellings *occupied* prior to treatment have much lower pre-intervention dust lead loadings on floors and interior window sills than dwellings *vacant* prior to treatment. **(Appendix Exhibit APP-1)** As in past reports, dust in dwellings *occupied* prior to treatment is analyzed separately from dwellings that were *vacant* prior to treatment. This report focuses primarily on the results in *occupied* dwellings where the effectiveness of lead interventions can be examined without the confounding effects of vacancy.

<u>Changes From Pre-Intervention (Phase 01) Through Six-Months Post-Intervention (Phase 03)</u>

Floors

As of September 1, 1997, grantees had submitted pre-intervention, clearance *and* six month floor (Phase 01, 02, and 03) dust lead results for 892 occupied dwellings. The median floor dust lead level of these dwellings declined slightly at clearance and then, somewhat surprisingly, continued to decline during the six months after clearance (**Exhibit 29**). The Phase 03 median dust lead levels were 30 percent lower than the Phase 01 levels. The declines in dust lead levels were even more pronounced in dwellings with higher floor loadings. The floor dust lead levels at the 90th percentile declined 67 percent from Phase 01 to Phase 03.

For the 11 grantees that reported results for at least 25 dwellings, their individual results were generally consistent with the pattern of all grantees. Median loadings were less likely to decline during both intervals, probably as a result of the relatively low pre-intervention levels. One grantee, Boston, stood out as going against the pattern, as its median floor lead loadings increased 30 $\mu g/ft^2$ (150%) between Phase 01 and Phase 02, but then declined below the Phase 01 levels at Phase 03.

Baltimore and Cleveland’s floor lead levels are also of interest, because, unlike the other grantees, their median and 90th percentile levels both increased between Phase 02 and Phase 03. There may be some environmental factor in these communities that contributes to floor dust lead reaccumulation, since Cleveland and Baltimore also reported the highest pre-intervention levels of floor dust lead (**Appendix Exhibit APP-2)**. In addition, anecdotal evidence suggests that Baltimore had a higher rate of vacancies post-intervention than other grantees. Since the occupancy status of these exhibits is based on just the Phase 01 occupancy, Baltimore's floor lead levels may have been affected by the vacancies. As previously noted, vacant dwellings tend to have higher dust lead levels.

Two grantees, Vermont and Minnesota, displayed no change in the median floor lead loadings between Phases 01 and 03. These observations are most likely the result of the limits of detection that the environmental laboratories used for these grantees[6]. Dust lead loadings may have changed, but those changes were too small to be observed.

Interior Window Sills

In contrast to the results for floor lead loading, interior window sill lead loadings tended to rise from Phase 02 to Phase 03 in the 877 occupied dwellings with data available (**Exhibit 30**). The median Phase 02 dust lead level across all grantees was 18 percent of the pre-intervention levels before Phase 03 levels rebounded to 32 percent of the baseline levels. The reductions were larger in units with the 90th percentile of sill dust lead loadings, where six-month levels were just four percent of clearance and 15 percent of the pre-intervention levels.

The results for individual grantees appear to be similar to the overall results, but the changes were not uniform. Rhode Island reported the third highest median window sill dust lead levels in Phase 01, but had the lowest levels at clearance (a decline to just five percent of pre-intervention levels). By Phase 03, the levels were back to fifth among the 11 grantees contributing at least 25 dwelling units, although the dust lead loadings were still only 20 percent of pre-intervention levels. In contrast, Baltimore did not achieve the same performance at clearance (median sill lead at Phase 02: 49 $\mu g/ft^2$ vs. 17 $\mu g/ft^2$ in Rhode Island), yet Baltimore had one of the lower rates of reaccumulation and was able to maintain its post-intervention levels at six-months (68 $\mu g/ft^2$ vs. 73 $\mu g/ft^2$) in Rhode Island. With more sophisticated analyses, the Evaluation will begin to look at why these contrasting patterns emerged and why Baltimore was able to maintain low short-term reaccumulation rates on window sills, but not on floors.

Also of interest are the activities of Milwaukee. Milwaukee had some of the highest interior window sill dust lead loadings in Phase 01, and had the highest median and 90th percentile dust lead levels in Phase 02. Milwaukee then exhibited one of the largest rates of reaccumulation over six months (301% at the median) which resulted in sill lead levels twice those of all grantees except for Cleveland. In more than ten percent of Milwaukee's treated dwellings, the Phase 03 sill levels were more than twice the current clearance standards. One explanation to be explored is the fact that one quarter of Milwaukee's dwelling units received only the most basic cleaning as a treatment. While the combination of Milwaukee's various approaches was able to maintain the steady levels on floors, they do not appear as successful on window sills.

Window Troughs

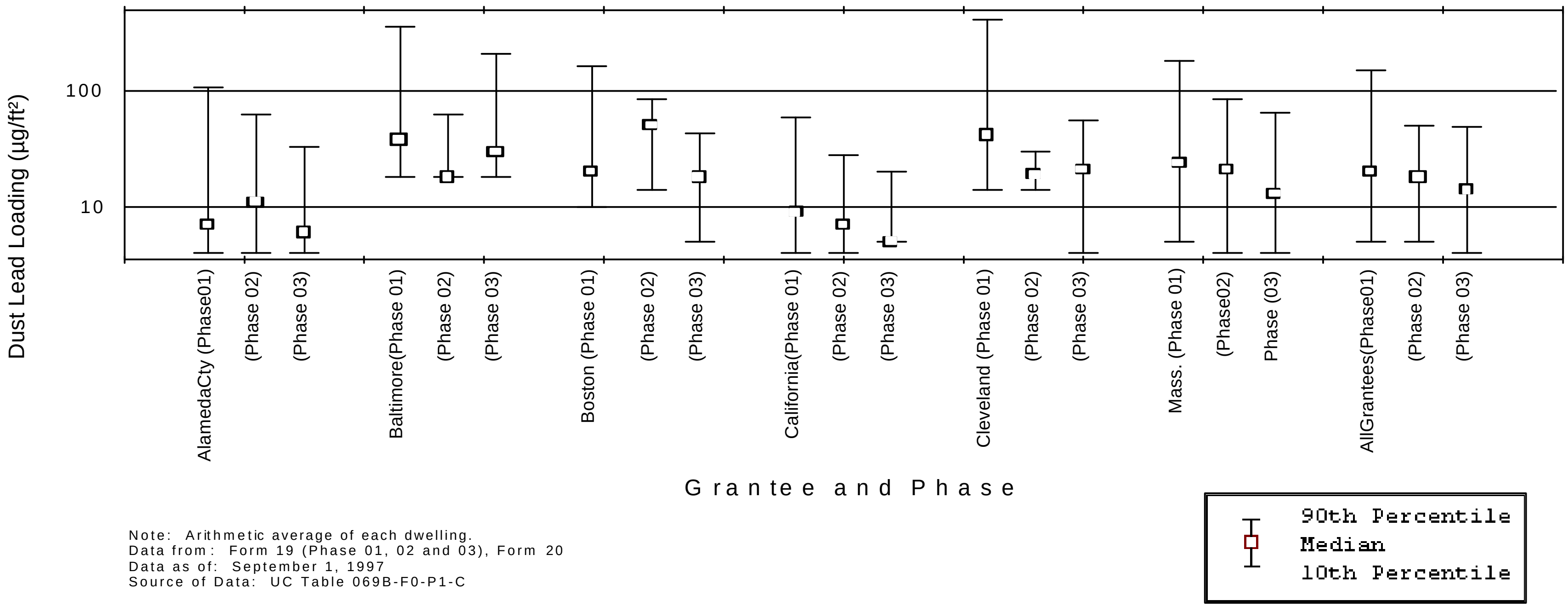
Window trough lead loadings showed an even greater tendency toward reaccumulation over the approximately six month period between Phases 02 and 03 (**Exhibit 31**). For the 731 occupied dwellings with dust lead loading reported in all three phases, the median trough loading

[6] Vermont's effective limit of detection on floors was 30 $\mu g/ft^2$; Minnesota's limit of detection was 20-25 $\mu g/ft^2$.

Exhibit 29: Floor Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 1 of 2

(Grantee specific data shown when at least 25 dwelling units submitted)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-F0-P1-C

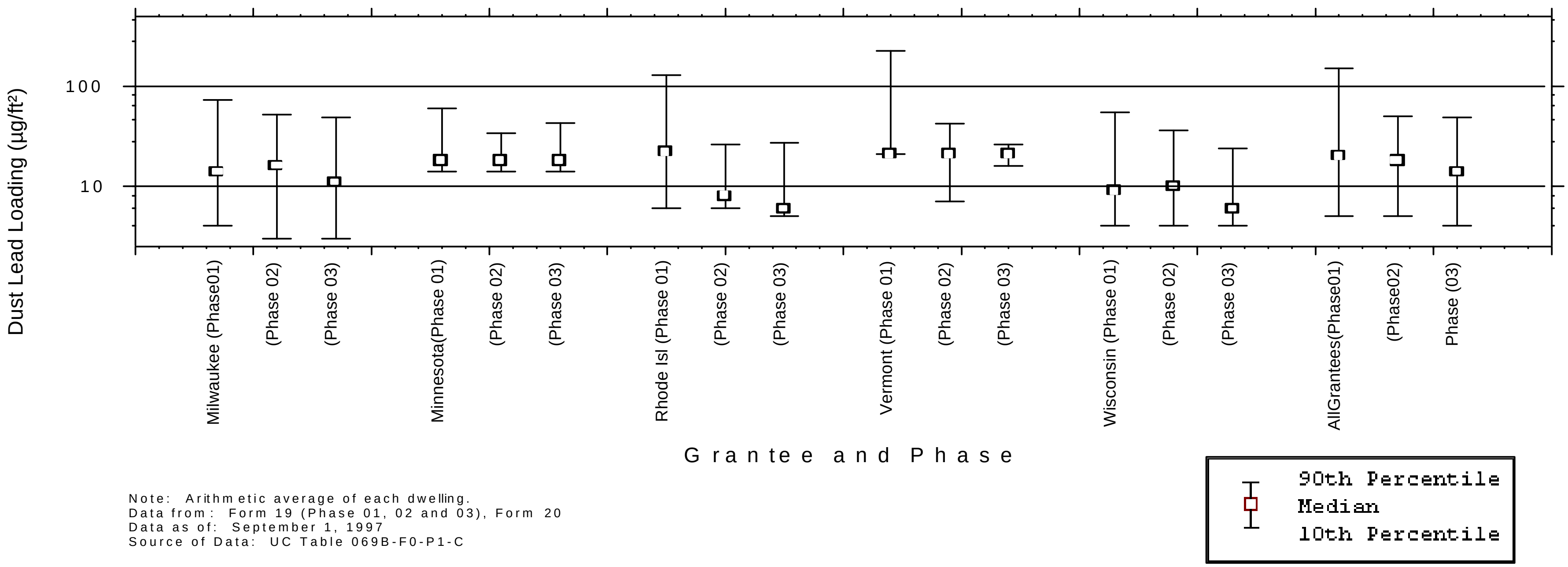
Numeric Values for Exhibit 29

	Alameda County			Baltimore			Boston			California			Cleveland			Massachusetts			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	4	4	4	18	18	18	10	14	5	4	4	5	14	14	4	5	4	4	5	5	4
Median	7	11	6	38	18	30	20	50	18	9	7	5	41	19	21	24	21	13	20	18	14
90th Percentile	107	63	33	360	63	210	164	85	43	59	28	20	415	30	56	181	85	65	150	50	49
Number of Dwellings	60	60	60	66	66	66	42	42	42	43	43	43	32	32	32	82	82	82	892	892	892

Exhibit 29: Floor Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 2 of 2

(Grantee specific data shown when atleast 25 dwelling units submitted)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-F0-P1-C

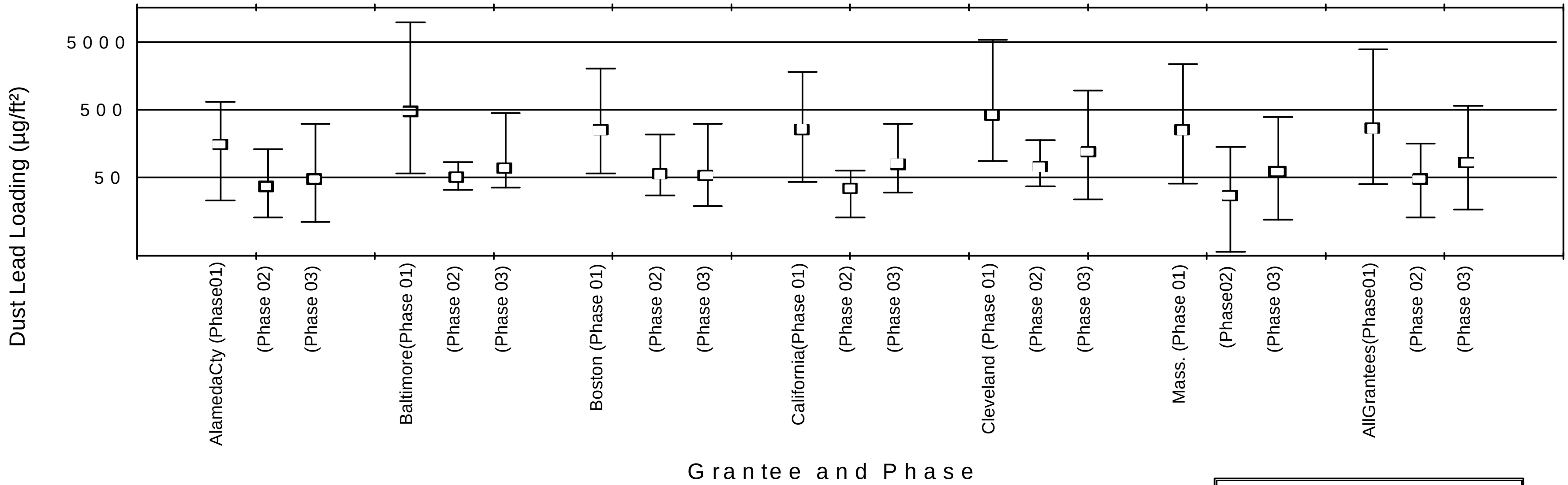
Numeric Values for Exhibit 29

	Milwaukee			Minnesota			Rhode Island			Vermont			Wisconsin			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	4	3	3	14	14	14	6	6	5	21	7	16	4	4	4	5	5	4
Median	14	16	11	18	18	18	22	8	6	21	21	21	9	10	6	20	18	14
90th Percentile	73	52	49	60	34	43	129	26	27	226	42	26	55	36	24	150	50	49
Number of Dwellings	200	200	200	120	120	120	61	61	61	93	93	93	78	78	78	892	892	892

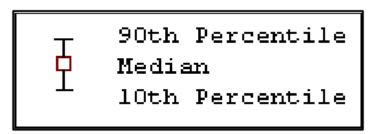
Exhibit 30: Window Sill Dust Lead Loadings ($\mu g/ft^2$) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 1 of 2

(Grantees included if included in Exhibit 29)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-S0-P1-C



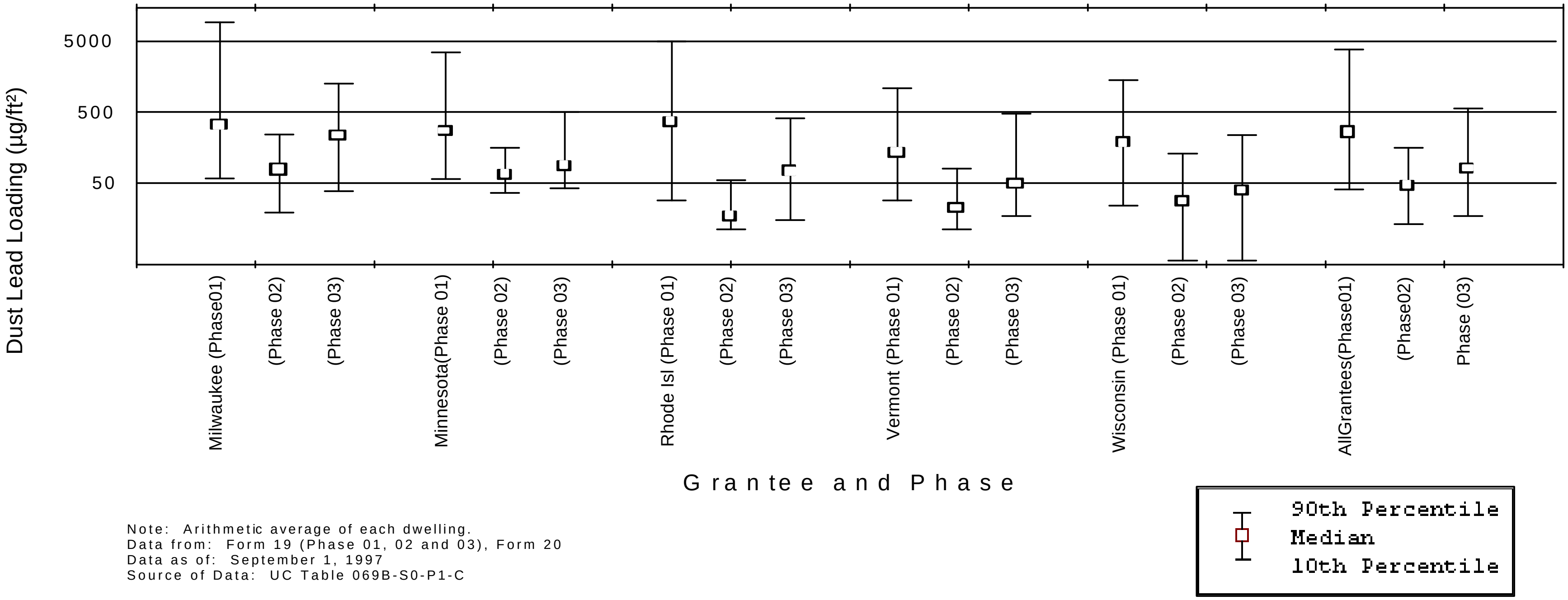
Numeric Values for Exhibit 30

	Alameda County			Baltimore			Boston			California			Cleveland			Massachusetts			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	23	13	11	57	33	36	57	27	19	43	13	30	88	37	24	41	4	12	40	13	17
Median	151	37	46	464	49	68	241	55	53	252	34	78	416	70	118	242	27	60	257	46	81
90th Percentile	656	132	310	9640	84	445	2006	214	312	1813	63	307	5415	176	958	2364	142	392	3857	158	568
Number of Dwellings	64	64	64	66	66	66	42	42	42	42	42	42	30	30	30	84	84	84	877	877	877

Exhibit 30: Window Sill Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 2 of 2

(Grantee included if included in Exhibit 29)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-S0-P1-C

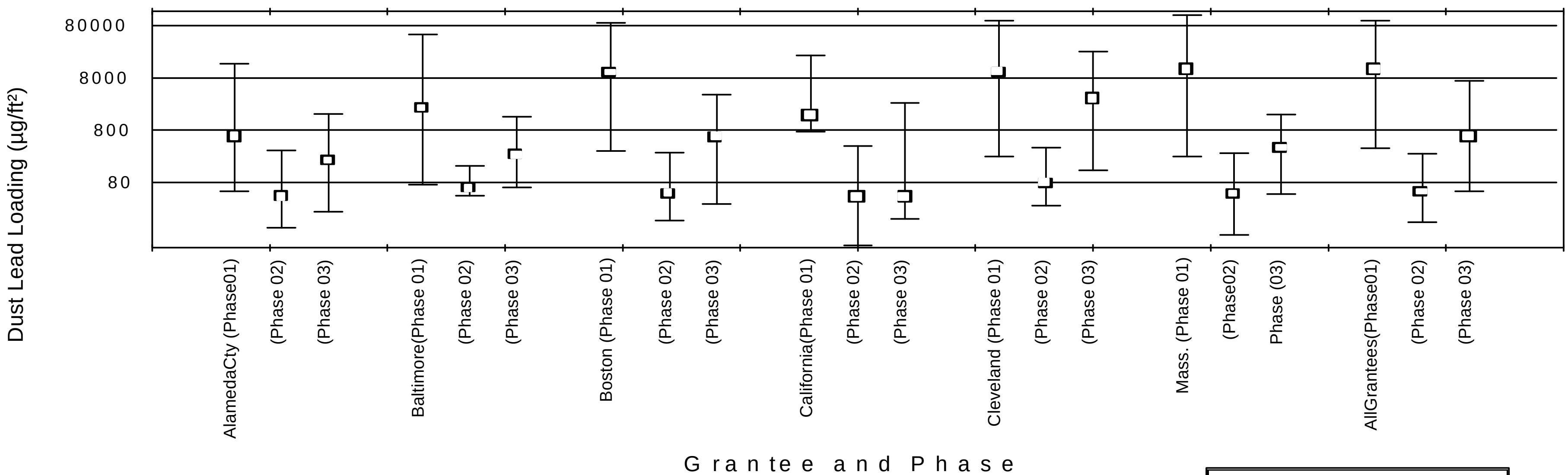
Numeric Values for Exhibit 30

	Milwaukee			Minnesota			Rhode Island			Vermont			Wisconsin			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	58	19	38	57	36	42	28	11	15	28	11	17	24	4	4	40	13	17
Median	325	77	232	266	66	88	364	17	73	135	22	49	185	27	39	257	46	81
90th Percentile	9365	240	1274	3517	158	503	5017	55	408	1082	79	474	1420	129	239	3857	158	568
Number of Dwellings	196	196	196	121	121	121	62	62	62	79	79	79	76	76	76	877	877	877

Exhibit 31: Window Trough Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 1 of 2

(Grantees included if included in Exhibit 29)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-T0-P1-C
Italicized data >99999

90th Percentile
Median
10th Percentile

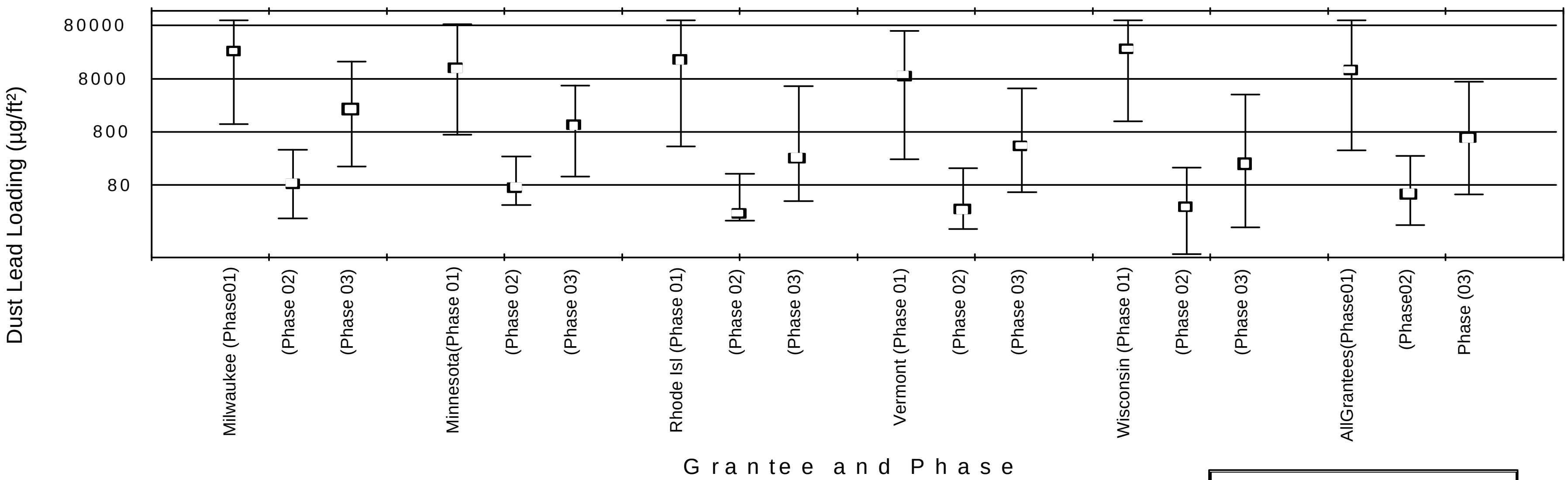
Numeric Values for Exhibit 31

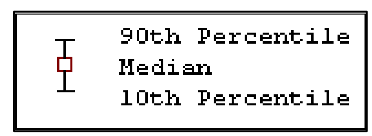
	Alameda County			Baltimore			Boston			California			Cleveland			Massachusetts			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	54	11	22	72	45	64	322	15	31	755	5	16	250	29	137	253	8	48	359	14	54
Median	598	43	208	2076	62	270	10079	50	590	1515	42	42	10293	79	3167	11540	49	362	11559	54	603
90th Percentile	15191	326	1657	54000	168	1450	9577	300	3889	21633	395	2670	*99999*	375	25764	127500	288	1588	*99999*	284	7072
Number of Dwellings	36	36	36	60	60	60	38	38	38	7	7	7	22	22	22	80	80	80	731	731	731

Exhibit 31: Window Trough Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention) - Page 2 of 2

(Grantee included if included in Exhibit 29)

(Logarithmic Scale)





Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069B-T0-P1-C
Italicized data > 99999

Numeric Values for Exhibit 31

	Milwaukee			Minnesota			Rhode Island			Vermont			Wisconsin			All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	1120	19	179	709	34	116	425	17	40	246	12	59	1260	4	13	359	14	54
Median	26306	85	2080	12207	72	1033	17537	23	255	8843	27	431	28009	30	198	11559	54	603
90th Percentile	99999	371	16900	84102	279	5885	*99999*	130	5782	62550	165	5215	*99999*	169	4033	*99999*	284	7072
Number of Dwellings	182	182	182	100	100	100	59	59	59	78	78	78	64	64	64	731	731	731

increased more than ten-fold (from 54 μg/ft^2 to 603 μg/ft^2) from Phase 02 to 03. Despite the increase, the median Phase 03 window trough dust lead loading was less than 6 percent of the pre-intervention median level (11,559 μg/ft^2). At the 90th percentile, the changes were even more pronounced, with trough levels falling from over 99,999 μg/ft^2 to 284 μg/ft^2 and then back to 7,072 μg/ft^2.

Depending on one's point of view, the six-month results are a success story or a point of concern. Six months after the intervention, the median trough lead levels were only five percent of the pre-intervention levels, possibly indicating that a much safer environment was created for the resident children. Yet, after the contractors focused on bringing the trough levels below the EPA and HUD Guidance level of 800 μg/ft^2, that level could not be maintained for six months in at least 25 percent of the dwellings.

To varying degrees, each grantee displayed the same pattern of dust lead changes. As with window sills, Rhode Island had the most success of any grantee cleaning the troughs. The rate of reaccumulation on troughs in Rhode Island, however, was fairly consistent with the Evaluation median (a ten-fold increase). Wisconsin and Milwaukee had the highest median pre-intervention window trough dust lead levels. At clearance, their paths diverged, with Milwaukee maintaining the highest median trough lead levels in Phase 02 and 03, while Wisconsin fell to one of the lowest levels of all of the grantees. Once again, the intensity of treatments, especially in Milwaukee, needs to be explored as a possible explanation.

Occupancy Effects

In at least 144 dwelling units, pre-intervention dust samples were collected from a dwelling that was vacant during Phase 01 and dust wipes were collected in the next two phases without any indication of having been occupied. For all wiped components, the dust sample results at clearance were very similar in vacant and occupied dwellings (**Exhibit 32**). The median dust lead loadings for Phase 02 vacant and occupied dwellings were: 21 vs 18 μg/ft^2 on floors, 42 vs 46 μg/ft^2 on sills, and 60 vs 54 μg/ft^2 on troughs, respectively. While the vacant units might be considered great success stories given the magnitude of the change on floors and sills from Phase 01 to Phase 02, the magnitude of the change can be attributed largely to the high pre-intervention dust lead levels in the vacant properties of this Evaluation.

From Phase 02 to Phase 03, the reaccumulation rates are fairly comparable between the two classes of dwellings. What differences exist can be largely attributed to the influence of Baltimore which provides roughly 55 percent of the vacancy data. (In previously occupied units, Baltimore has greater floor dust lead and lesser window dust lead reaccumulation than other grantees.) These findings are not particularly surprising since many of the dwellings that were vacant in Phase 01 were occupied shortly after treatment and were by and large the same as the other grouping following the intervention.

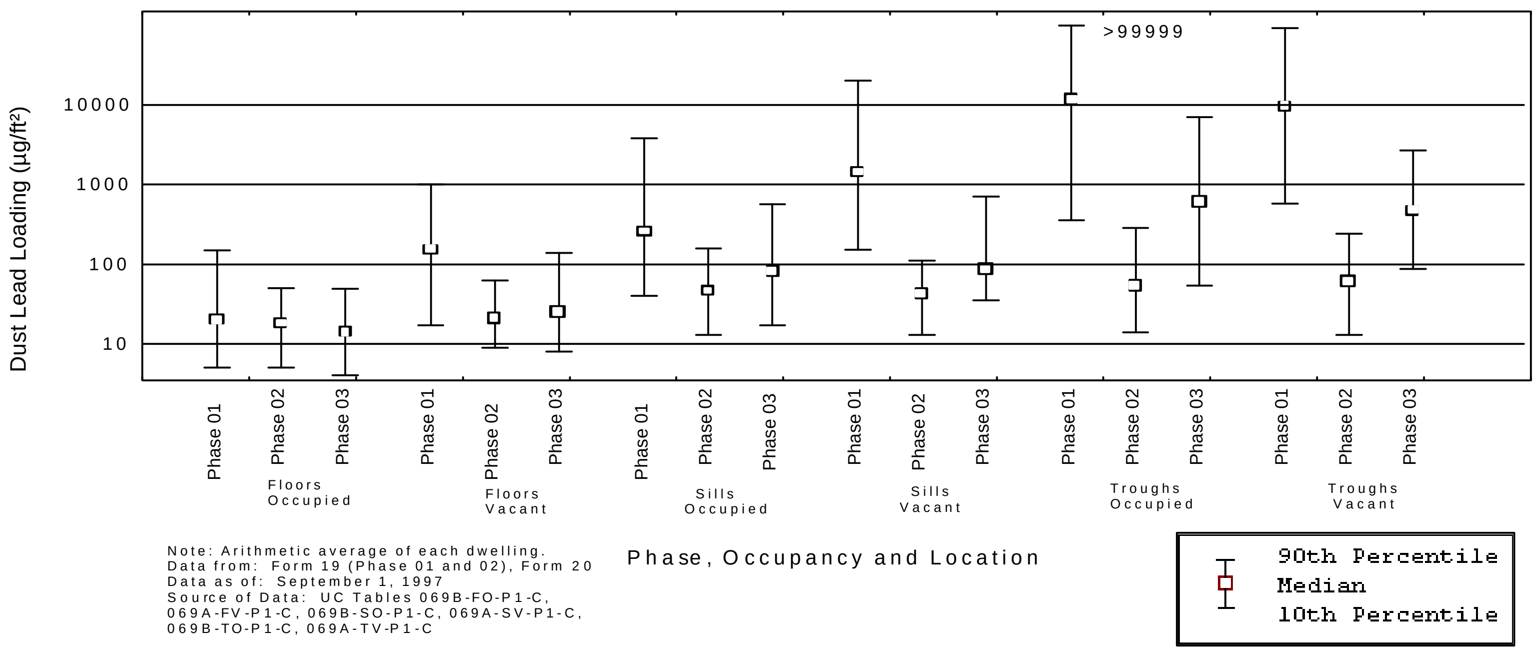
Changes From Pre-Intervention (Phase 01) To Twelve-Months Post-Intervention (Phase 04)

Floors

Because the Evaluation is ongoing, the number of dwelling units with floor dust sample results from all four phases of the study is more limited. Even with less data, some tendencies are emerging. As discussed in the previous section, floor dust lead levels tend to decline from

Exhibit 32: Dust Lead Loadings (µg/ft²) in Vacant and Occupied Dwellings for Locations Sampled Phases 01, 02 & 03 (Pre-Intervention, Immediate Post, and Six Month Post-Intervention)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01 and 02), Form 20
Data as of: September 1, 1997
Source of Data: UC Tables 069B-FO-P1-C, 069A-FV-P1-C, 069B-SO-P1-C, 069A-SV-P1-C, 069B-TO-P1-C, 069A-TV-P1-C

Numeric Values for Exhibit 32

	Occupied Floors			Vacant Floors			Occupied Sills			Vacant Sills			Occupied Troughs			Vacant Troughs		
	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03	Phase 01	Phase 02	Phase 03
10th Percentile	5	5	4	17	9	8	40	13	17	151	13	35	359	14	54	576	13	87
Median	20	18	14	152	21	25	257	46	81	1436	42	86	11559	54	603	9605	60	470
90th Percentile	150	50	49	1002	63	139	3857	158	568	20344	111	713	>99999	284	7072	92244	242	2700
Number of Samples	892	892	892	154	154	154	877	877	877	153	153	153	731	731	731	144	144	144

Phase 01 to Phase 02 and continue to decline slightly from Phase 02 to Phase 03. Based on the 557 dwelling units with four phases of floor samples reported as of September 1, 1997, it appears as though floor lead levels stay stable or slightly increase between Phase 03 and Phase 04 (**Exhibit 33**). In most dwellings, the twelve month intervention dust lead levels remained below the pre-intervention limits. Only Baltimore had floor lead levels of 100 $\mu g/ft^2$ or more in over ten percent of its Phase 04 dwellings.

Interior Window Sills

Over the lower sections of the distribution of window sill dust lead levels, the levels exhibited an unexpected pattern: between Phases 03 and 04, the dust lead levels declined slightly (**Exhibit 34**). A similar pattern was displayed by at least half of the grantees. It should be noted, however, that the declines were often limited to a few micrograms per square foot and are well within the margin of error of the dust wiping protocols. Yet, even if these declines are the result of sampling variation, the data strongly suggest that there was little change in dust lead levels between Phase 03 and 04 for a majority of the occupied dwellings in the Evaluation. Further analytical tests will have to be conducted to attempt to explain this apparent tendency, including an examination of the influence of seasons.

Window Troughs

Like interior window sills, the window trough dust lead levels generally declined between Phases 03 and 04 (**Exhibit 35**). Unlike window sills, the tendency was apparent across the distribution of dwellings for seven of the eight grantees with four phases of samples for at least 25 dwelling units. Only Milwaukee, where window trough levels continued to rise significantly between Phase 03 and 04, did not follow the pattern. The upward trend in Milwaukee is apparent across the entire distribution of trough lead loadings, suggesting that factors beyond the choice of treatments that may be influencing changes in Milwaukee's window dust lead levels. For all grantees, the tendency to decline between Phase 03 and 04 was dampened by Milwaukee which provided 34 percent of the data.

As with window sills, the declines of the trough lead loadings between Phase 03 and 04 warrant further investigation. In addition to the possible influence of season, it is also possible that the study design had some influence on both the sill and trough findings. The study protocols called for half of a window to be wipe tested in Phase 02, the other half to be wiped in Phase 03, and the first half to be wiped again in Phase 04. Therefore, the half of the window that was wiped in Phase 04 had been wiped immediately after the intervention while the half wiped in Phase 03 had not. Although these specific protocols have not always been followed consistently, the possible effects of this study design cannot be ruled out at this time.

Overall Changes

To summarize these preliminary results on dust lead loading changes: The interventions being carried out by grantees seem to be very effective at immediately reducing window trough and window sill dust lead loadings. Despite some reaccumulation during the six months after intervention, most of the net reduction in contamination of these surfaces persists. From six months to twelve months post-intervention, window lead levels appear to plateau or actually decline for the vast majority of the grantees. These later declines in window dust lead levels are especially apparent on window troughs suggesting that factors other than the interventions (i.e., external factors, season, study design) may be influencing the rates of reaccumulation.

For floors, the interventions appear to be reducing the number of dwellings with relatively high dust lead loadings, with less of an effect on the median lead loading. Most pre-intervention floor dust lead levels were close to the analytical limits of detection, so it is possible that the reported post-intervention levels may underreport actual declines. Floors also demonstrated little evidence of reaccumulation through twelve months post-intervention.

The Effect of the Interventions on Dust Lead Changes

A principal objective of the Evaluation, the assessment of the effect of the different lead hazard control techniques on dust lead level, has not yet been presented in this report. Up until this point, data were presented which summarized the overall changes in dust lead levels without an examination of the effects of any specific interventions. In this section, analyses are presented that begin to identify the impact of various lead hazard control interventions.

The flexibility that grantees had in designing their interventions and the diversity of the lead hazards found in their enrolled dwellings result in a complicated statistical analysis problem. As discussed in section II, a three-part strategy code is used to describe the lead hazard control work being performed on each dwelling unit/property. The intervention strategy describes the intensity of the treatments to three separate parts of the property: the interior of the dwelling unit[7], the exterior of the building, and the site surrounding the building. Strategy codes with higher numbers reflect more intensive treatments. One would hypothesize that dust lead levels in buildings that are treated with higher level strategies would display greater change than buildings receiving lower level strategies. It is not evident, however, how effectiveness of interventions in a building treated with a high level interior strategy and a lower level exterior strategy would compare with a building treated with a low level interior strategy and a higher level exterior strategy. When the site strategy levels are included as variables of interest, it is apparent that there are too many categories to draw conclusions from a simple analysis.

This section looks at the effect of interventions from two different perspectives. First, descriptive figures (**Exhibits 36, 37, and 38**) present changes in dust lead levels from Phase 02 to Phase 04 in dwellings treated with different interior and exterior strategies. The information focuses exclusively on interior and exterior interventions, because few dwellings with site based interventions have been reported so far. To avoid presenting complex figures, the figures for interior and exterior strategies are presented separately. In addition, these figures ignore the diversity of pre-intervention lead hazards and building conditions which influence the effectiveness of treatments.

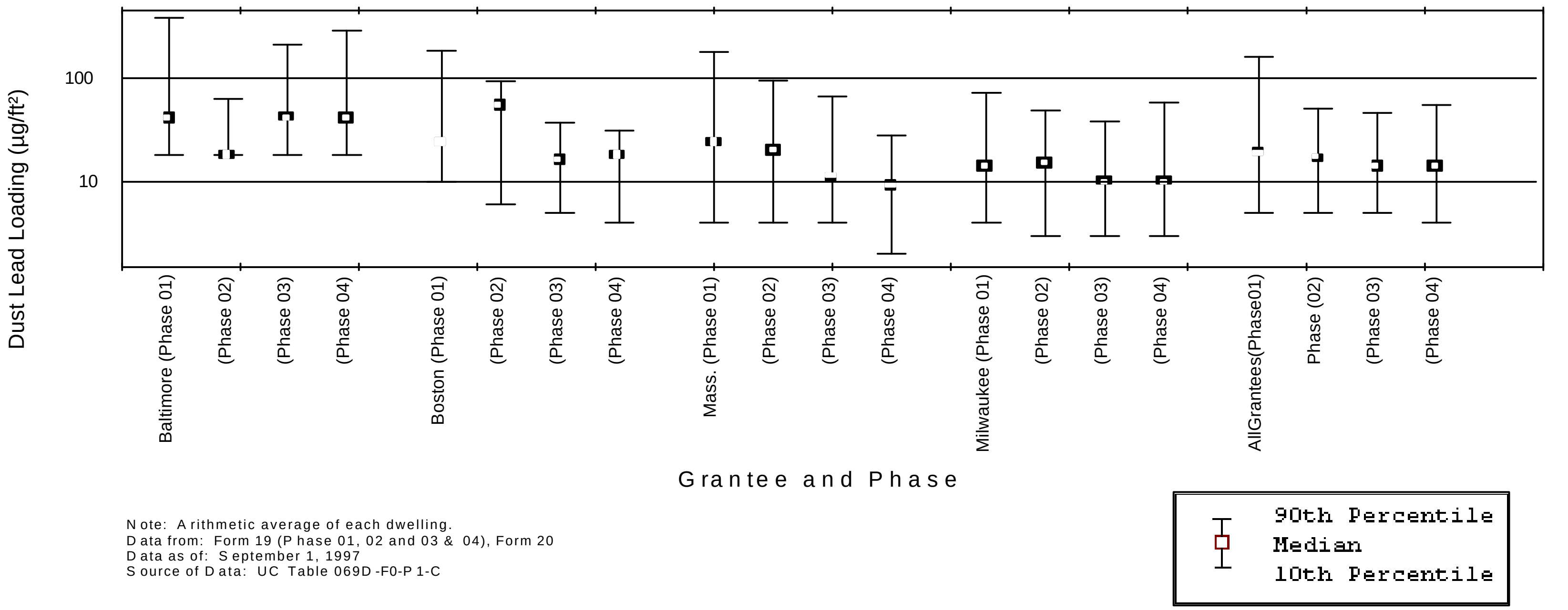
At the end of this section, multivariate statistical models are introduced. These statistical models offer tools to examine simultaneously the influence of the pre-intervention lead hazards, characteristics of the enrolled housing and pertinent family characteristics on the effectiveness of lead hazard control work. While these multivariate statistical models are more complex, they provide a more complete picture on how the baseline conditions and different strategy locations interact to affect changes in dust lead levels.

[7] Common area interior treatments and their effects on dust lead have not yet been analyzed.

Exhibit 33: Floor Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04 (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 1 of 2

(Grantee specific data shown when at least 25 dwelling units submitted)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069D-F0-P1-C

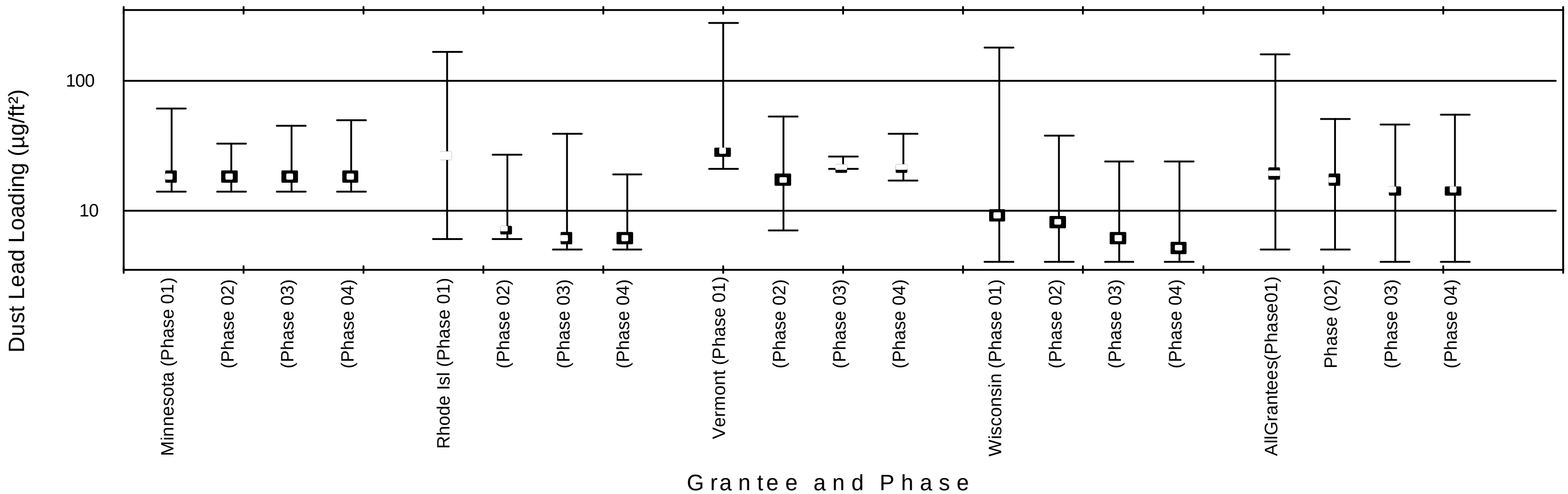
Numeric Values for Exhibit 33

	Baltimore				Boston				Massachusetts				Milwaukee				All Grantees			
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04
10th Percentile	18	18	18	18	10	6	5	4	4	4	4	2	4	3	3	3	5	5	4	4
Median	41	18	42	41	24	54	16	18	24	20	11	9	14	15	10	10	19	17	14	14
90th Percentile	382	63	210	289	183	93	37	31	179	95	67	28	72	49	38	58	160	51	46	55
Number of Dwellings	32	32	32	32	28	28	28	28	42	42	42	42	170	170	170	170	557	557	557	557
% Samples Below Limit of Detection	21%	77%	61%	60%	20%	18%	21%	40%	4%	6%	2%	7%	17%	13%	8%	8%	28%	48%	51%	49%

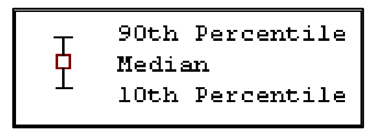
Exhibit 33: Floor Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04 (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 2 of 2

(Grantee specific data shown when at least 25 dwelling units submitted)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Tables 069D-F0-P1-C and 363



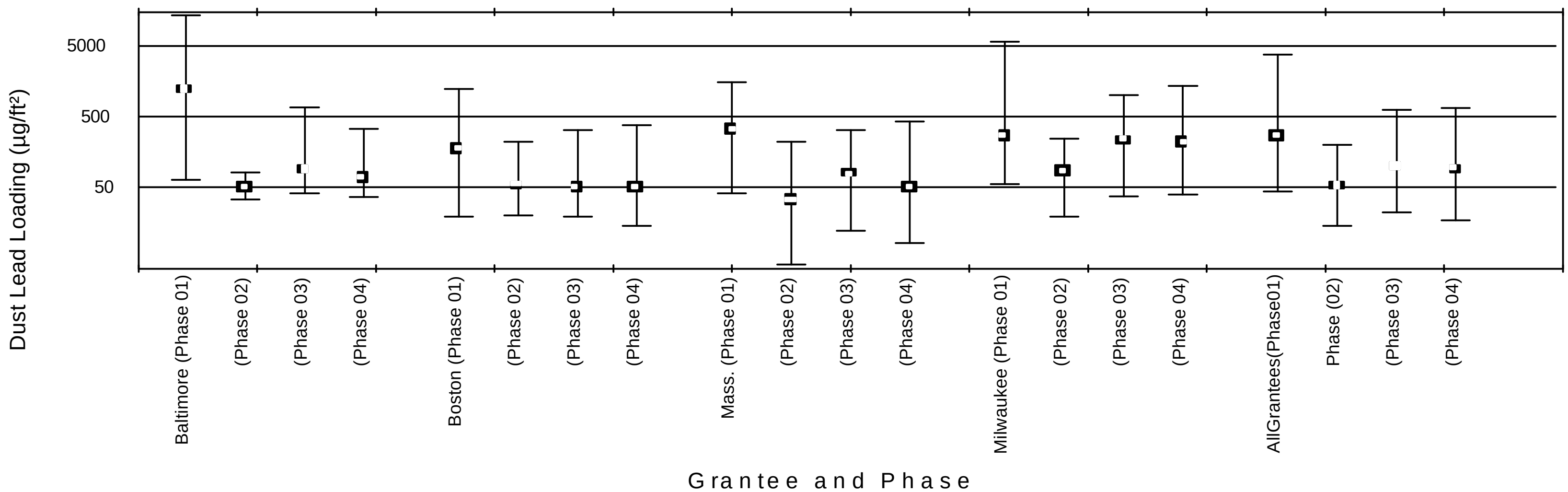
Numeric Values for Exhibit 33

	Minnesota				Rhode Island				Vermont				Wisconsin				All Grantees			
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04
10th Percentile	14	14	14	14	6	6	5	5	21	7	21	17	4	4	4	4	5	5	4	4
Median	18	18	18	18	26	7	6	6	28	17	21	21	9	8	6	5	19	17	14	14
90th Percentile	61	33	45	50	167	27	39	19	279	53	26	39	181	38	24	24	160	51	46	55
Number of Dwellings	105	105	105	105	31	31	31	31	43	43	43	43	48	48	48	48	557	557	557	557
% Samples Below Limit of Detection	67%	69%	76%	73%	22%	60%	68%	72%	47%	70%	86%	87%	31%	39%	48%	52%	28%	48%	51%	49%

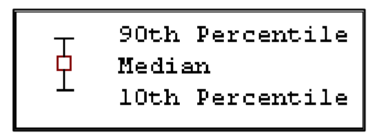
Exhibit 34: Sill Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04 (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 1 of 2

(Grantees included if included in Exhibit 33)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069D-S0-P1-C



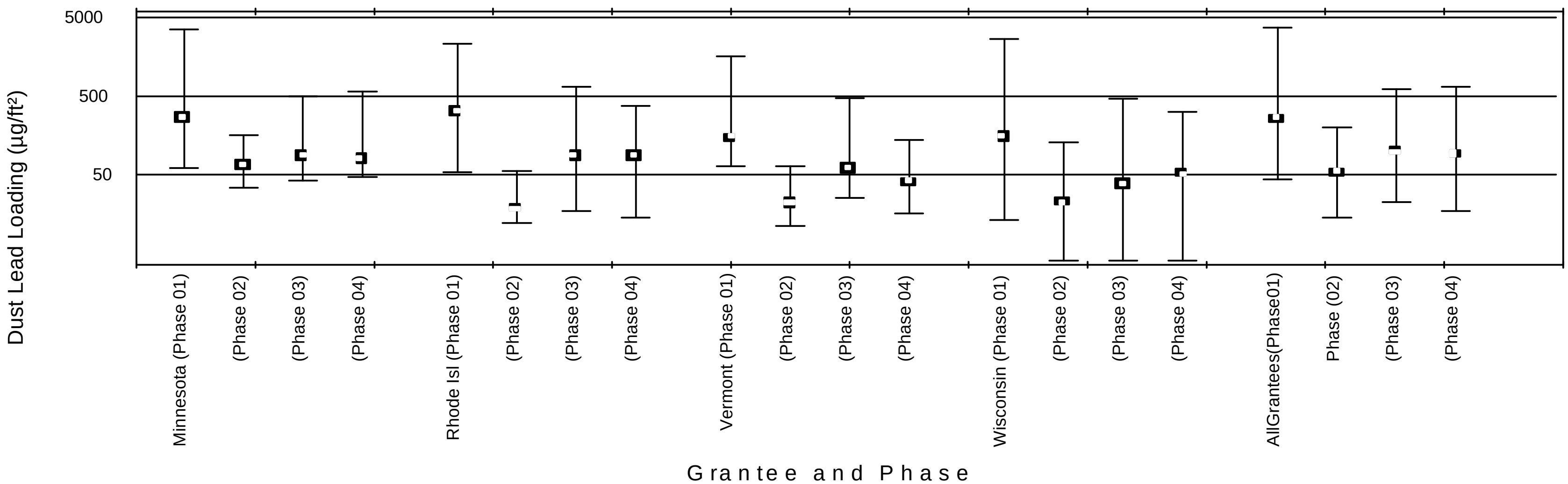
Numeric Values for Exhibit 34

	Baltimore				Boston				Massachusetts				Milwaukee				All Grantees			
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04
10th Percentile	63	33	41	36	19	20	19	14	41	4	12	8	55	19	37	39	43	14	22	17
Median	1191	49	87	68	174	53	48	49	328	32	77	50	264	84	231	217	258	52	97	90
90th Percentile	13372	81	669	335	1233	217	322	375	1531	218	317	420	5725	240	1002	1339	3767	199	616	652
Number of Dwellings	32	32	32	32	29	29	29	29	43	43	43	43	166	166	166	166	547	547	547	547
% Samples Below Limit of Detection	9%	87%	61%	61%	9%	29%	17%	22%	1%	13%	3%	7%	10%	25%	7%	6%	12%	51%	38%	34%

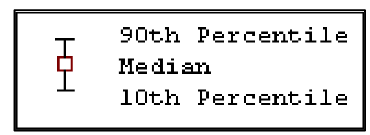
Exhibit 34: Sill Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04 (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 2 of 2

(Grantees included if included in Exhibit 33)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Tables 069D-S0-P1-C and 364



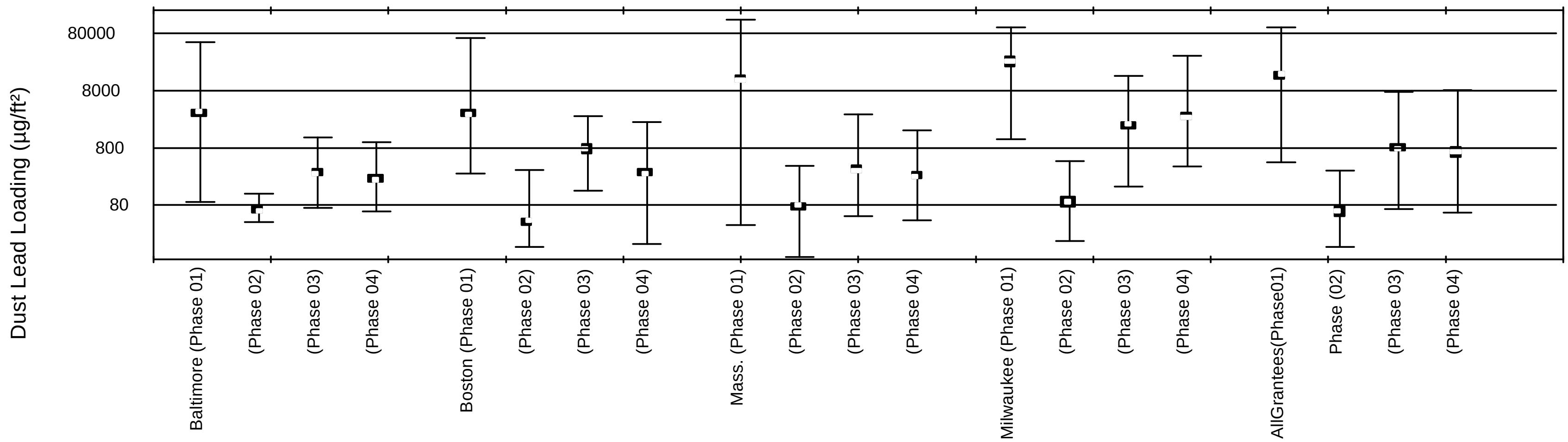
Numeric Values for Exhibit 34

	Minnesota				Rhode Island				Vermont				Wisconsin				All Grantees			
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04
10th Percentile	60	34	42	46	53	12	17	14	64	11	25	16	13	4	4	4	43	14	22	17
Median	266	66	86	77	314	18	87	85	147	21	60	40	150	22	37	51	258	52	97	90
90th Percentile	3517	158	500	569	2335	55	661	377	1600	64	474	137	2658	129	465	317	3767	199	616	652
Number of Dwellings	108	108	108	108	31	31	31	31	32	32	32	32	45	45	45	45	547	547	547	547
% Samples Below Limit of Detection	20%	61%	47%	47%	3%	68%	32%	38%	28%	66%	70%	54%	5%	42%	22%	21%	12%	51%	38%	34%

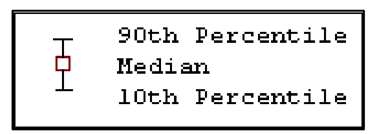
Exhibit 35: Trough Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04 (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 1 of 2

(Grantees included if included in Exhibit 33)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Tables 069D-T0-P1-C and 365
Data in italics >99999 µg/ft²



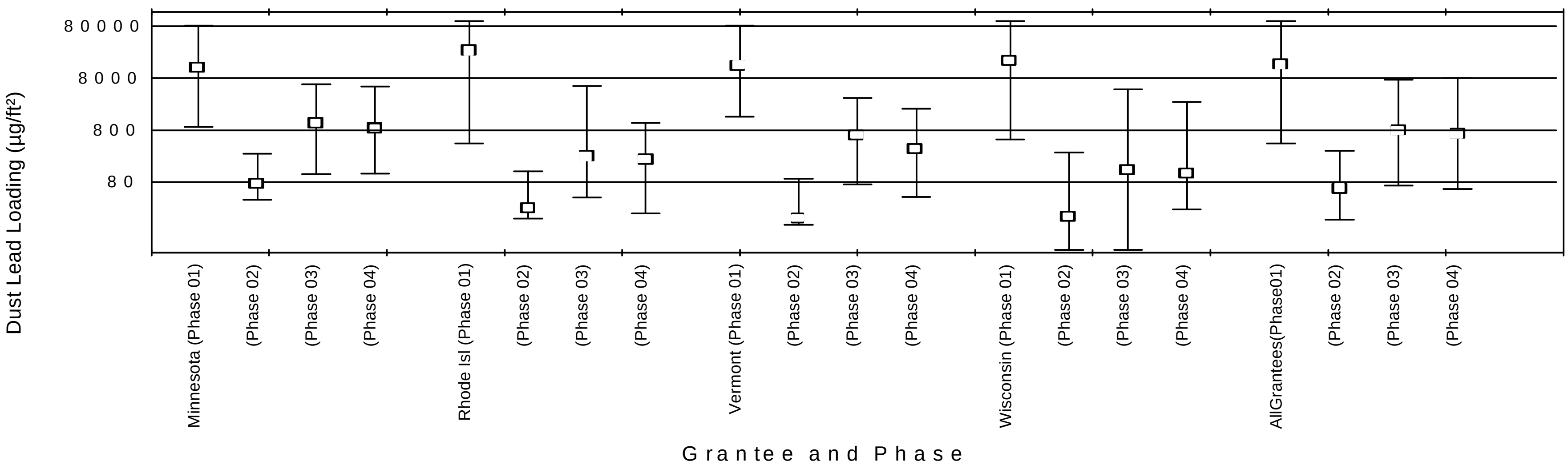
Numeric Values for Exhibit 35

	Baltimore				Boston				Massachusetts				Milwaukee				All Grantees			
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04
10th Percentile	90	41	71	62	286	15	143	17	36	10	52	44	1120	19	167	381	442	15	68	59
Median	3230	62	280	217	3084	40	731	284	12100	75	323	251	24100	88	1975	2733	14350	61	770	657
90th Percentile	56000	127	1200	1000	65515	328	2838	2264	136650	387	3070	1600	*99999*	469	14240	31900	*99999*	319	7500	8170
Number of Dwellings	28	28	28	28	26	26	26	26	39	39	39	39	152	152	152	152	448	448	448	448
% Samples Below Limit of Detection	5%	73%	16%	17%	3%	39%	10%	14%	0%	7%	1%	2%	1%	20%	1%	0%	2%	43%	10%	10%

Exhibit 35: Trough Dust Lead Loadings (µg/ft²) in Occupied Dwellings for Locations Sampled Phases 01, 02, 03, & 04, (Pre-Intervention, Immediate Post, Six, and Twelve Month Post-Intervention) - Page 2 of 2

(Grantees included ifincluded in Exhibit 33)

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data from: Form 19 (Phase 01, 02 and 03 & 04), Form 20
Data as of: September 1, 1997
Source of Data: UC Table 069D-T0-P1-C
Data in italics >99999 µg/ft²

Numeric Values for Exhibit 35

	Minnesota				Rhode Island				Vermont				Wisconsin				All Grantees		
	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03	Phase 04	Phase 01	Phase 02	Phase 03
10th Percentile	930	37	115	116	440	16	40	20	1451	12	73	41	524	4	4	24	442	15	68
Median	12470	74	1091	839	26622	25	244	215	14300	16	623	340	17338	17	140	117	14350	61	770
90th Percentile	82266	285	6144	5491	*99999*	130	5643	1107	82700	93	3330	2050	*99999*	294	4846	2770	*99999*	319	7500
Number of Dwellings	88	88	88	88	28	28	28	28	32	32	32	32	34	34	34	34	448	448	448
% Samples Below Limit of Detection	3%	48%	9%	10%	2%	59%	8%	14%	3%	51%	12%	19%	0%	42%	10%	6%	2%	43%	10%

Descriptive Changes in Dust Lead Levels by Strategy

Floors

Between Phase 02 and Phase 04, the median change in floor dust lead loadings at dwellings where treatment strategies were reported was a decline between 1 and 10 $\mu g/ft^2$. Floor dust lead levels declined more than 10 $\mu g/ft^2$ at nine percent of the dwellings that received the lowest level of interior treatment (cleaning and possibly spot painting) (**Exhibit 36**). In comparison, about 30 percent of the dwellings that received higher level interior treatments had declines in floor lead dust of more than 10 $\mu g/ft^2$. The percentage of dwellings where floor dust lead levels increased 11 $\mu g/ft^2$ or more was fairly consistent for each of the interior treatment strategies: about 20 percent.

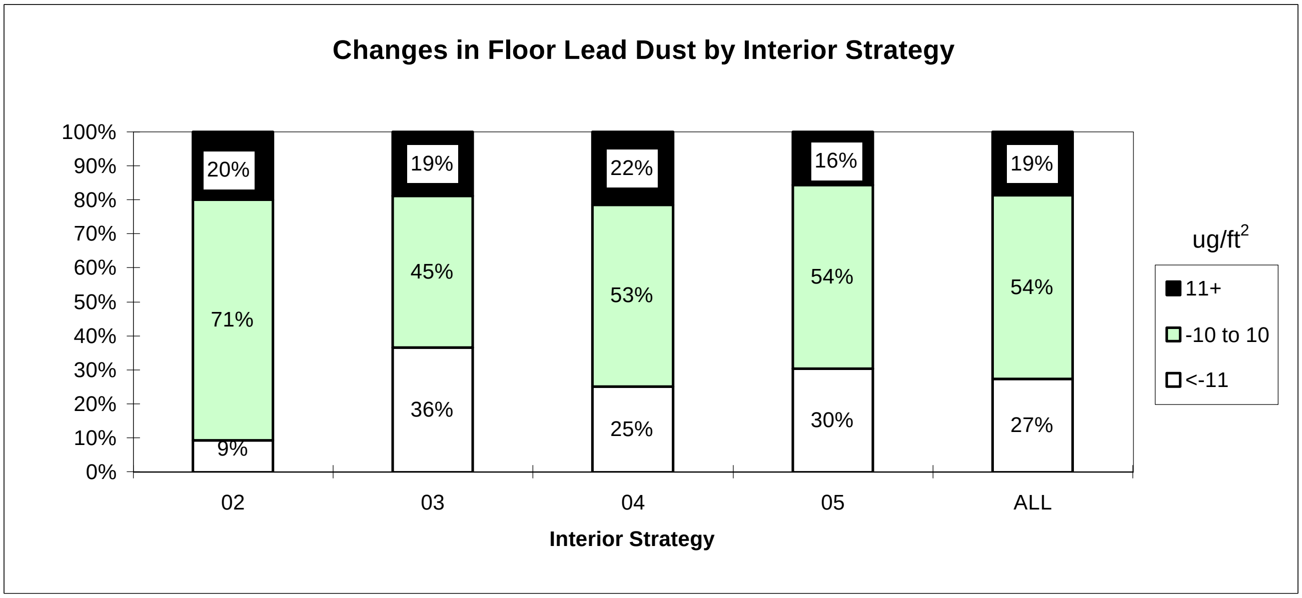
From clearance to 12 months after clearance, 10 percent of the dwellings where no exterior treatment was conducted had decreases in floor dust lead levels of more than 10 $\mu g/ft^2$, while 24 to 42 percent of dwellings where some exterior lead treatments were performed had declines of that same magnitude. Floor dust lead loadings at units that had partial exterior abatement (exterior strategy 03) *increased* more than 10 $\mu g/ft^2$ at 7 percent of the dwellings. Curiously, dwelling units in buildings where all exterior lead-based paint was at least enclosed or encapsulated (exterior strategy 04) did not appear to control leaded dust as well as exterior strategy 03; lead levels increased more than 10 $\mu g/ft^2$ at 24 percent of the dwellings.

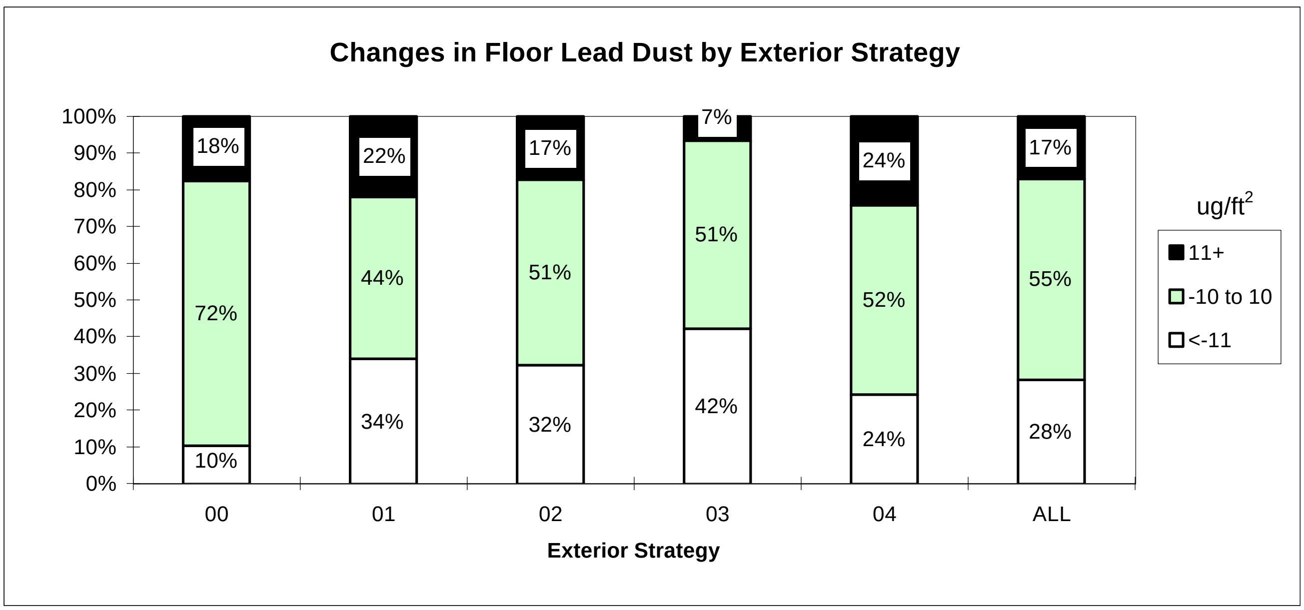
This last observation offers an opportunity to emphasize that these results cannot be used to pass final judgment on the effectiveness of certain treatments. In some units, grantees mixed exterior strategy 04 with lower level interior strategies including level 02. In some units, grantees may have been more likely to mix a certain exterior strategy with concurrent work that could have influenced lead reaccumulation. Furthermore, grantees may have selected higher level treatments in buildings or neighborhoods with worse environmental lead problems and vice versa. Any or all of these factors (as well as many others) could influence the perceived effectiveness of the different levels of treatments when effectiveness is measured by dust lead changes. Even so, findings that are unexpected, such as those for exterior strategy 04, warrant further investigation to better understand what may be occurring.

Interior Window Sills

At dwellings where treatment strategies were reported, the median change in window sill dust lead loadings was an increase of between 26 and 50 $\mu g/ft^2$ between Phase 02 and Phase 04. The percentage of dwellings where the window sill dust lead loadings either declined or increased less than 26 $\mu g/ft^2$ progressively increased from 36 percent of units treated with interior strategy 03 to 57 percent of units treated with interior strategy 05 (**Exhibit 37**). Conversely, the percentage of dwellings where the sill dust lead levels increased more than 50 $\mu g/ft^2$ progressively decreased from 61 to 36 percent for interior strategies 03 to 05. These trends are not observed between interior strategy 02 and 03. These observations are logically consistent with the strategy coding, because the treatments to window sills are very similar for strategies 02 and 03 (paint stabilization), while the sill treatments are more intensive at the higher levels.

Exhibit 36: Changes in Floor Dust Lead Loading ($\mu g/ft^2$) Between Phase 04 (12 Months Post-Intervention) and Phase 02 (Immediate Post-Intervention) for Occupied Dwellings by Interior and Exterior Strategy Code





Note 1: Change represented by arithmetic mean dust lead loading from each dwelling at Phase 04 minus dwelling arithmetic mean at Phase 02.

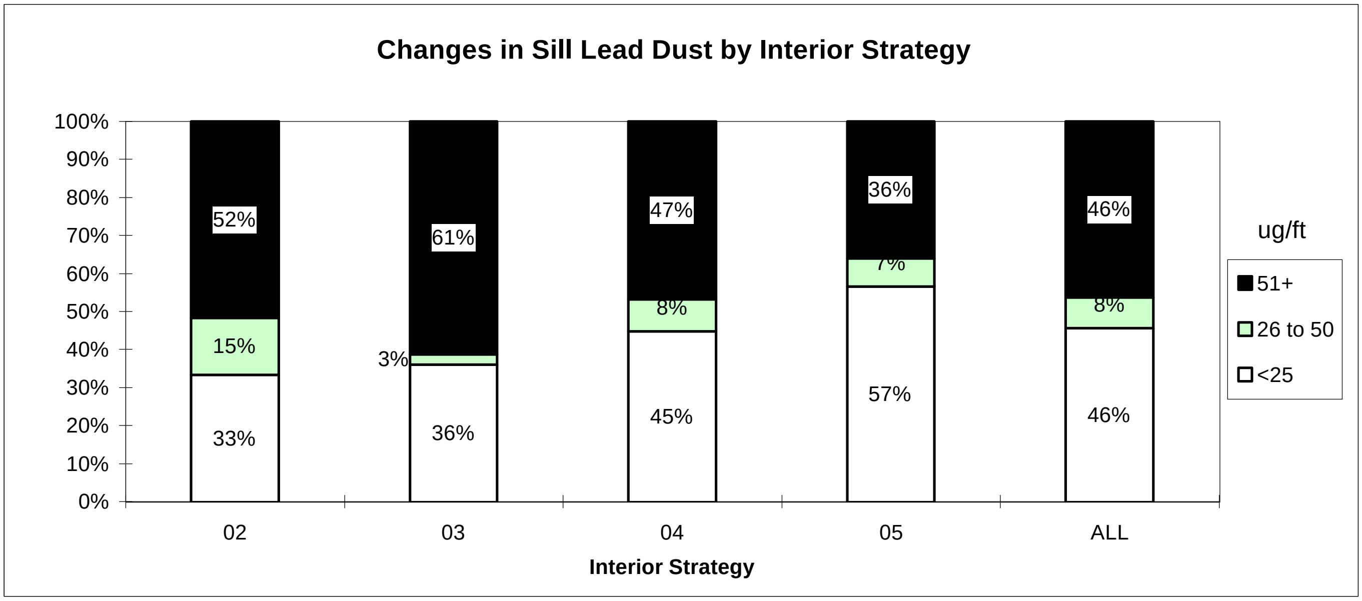
Note 2: Interior Strategy Codes: 01=No Action, 02=Cleaning/Spot Painting, 03=02 + Full Painting, 04=03 + Window Treatment, 05=04 + Windows, 06=05 + Public Housing Standard, 07=Lead Free.
Exterior Strategy Codes: 00=No Action, 01=Partial Paint Stabilization, 02=Complete Paint Stabilization, Porch Treatments, 03=02 + Porch/Trim Enclosure and Stabilization, 04=All Lead Paint Enclosed or Removed, 05=All Lead Paint Removed.
See Exhibit 11 for detailed strategy definitions.

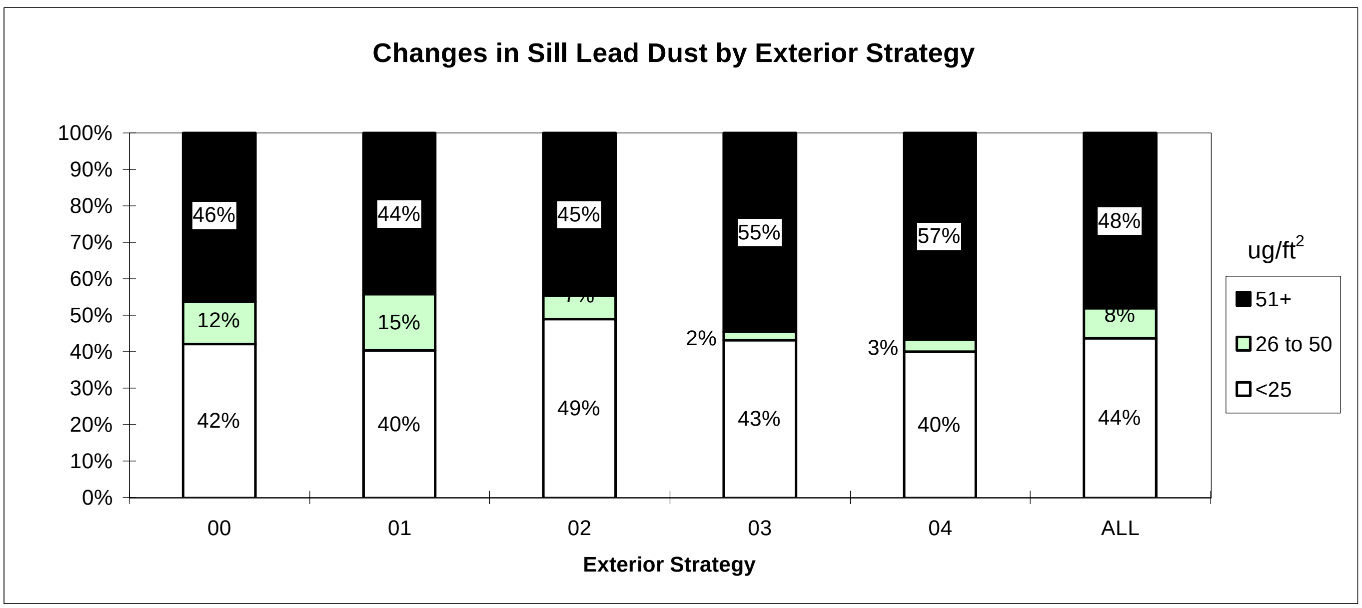
Data From: Form 01, Form 19, (Phase 02 and 04), Form 23

Data as of: September 1, 1997

Source of Data: UC Table 387A and 388A

Exhibit 37: Changes in Sill Dust Lead Lead Loading (µg/ft^2) Between Phase 04 (12 Months Post-Intervention) and Phase 02 (Immediate Post-Intervention) for Occupied Dwellings by Interior and Exterior Strategy Code





Note 1: Change represented by arithmetic mean dust lead loading from each dwelling at Phase 04 minus dwelling arithmetic mean at Phase 02.

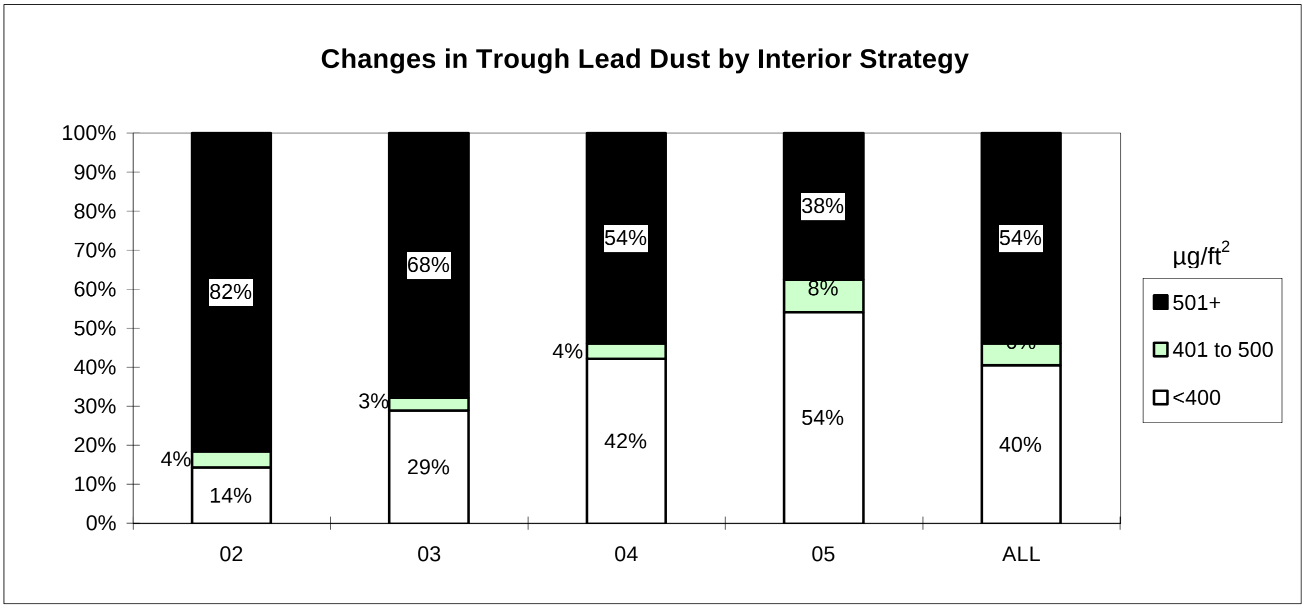
Note 2: Interior Strategy Codes: 01=No Action, 02=Cleaning/Spot Painting, 03=02 + Full Painting, 04=03 + Window Treatment, 05=04 + Windows, 06=05 + Public Housing Standard, 07=Lead Free.
Exterior Strategy Codes: 00=No Action, 01=Partial Paint Stabilization, 02=Complete Paint Stabilization, Porch Treatments, 03=02 + Porch/Trim Enclosure and Stabilization, 04=All Lead Paint Enclosed or Removed, 05=All Lead Paint Removed.
See Exhibit 11 for detailed strategy definitions.

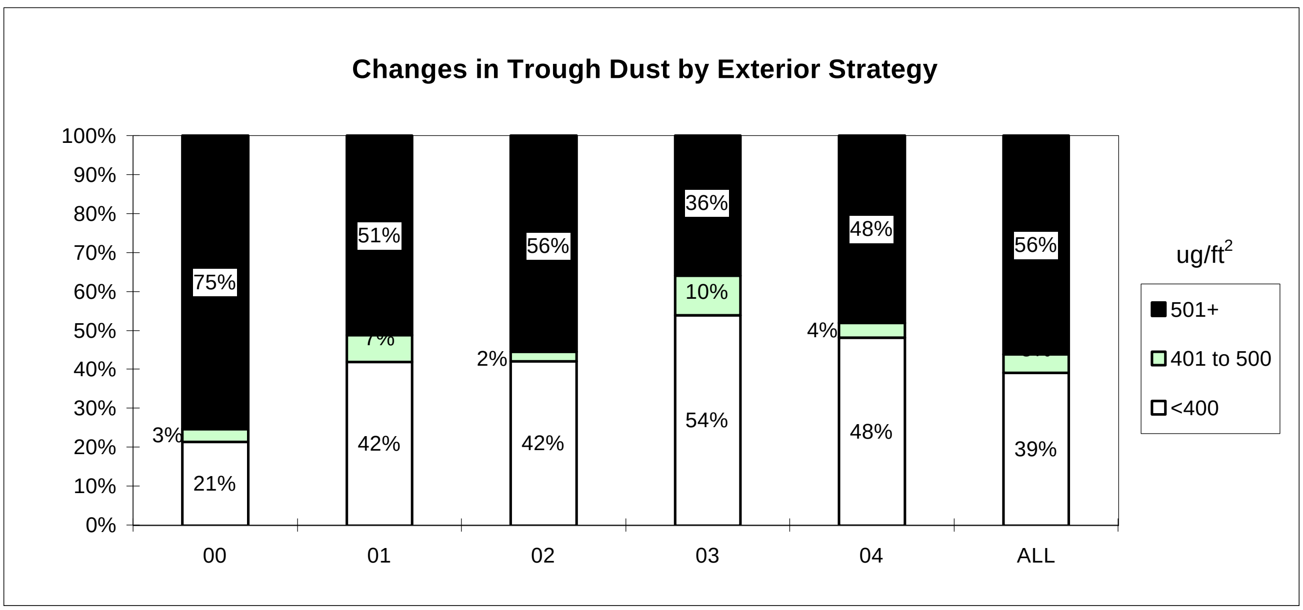
Data From: Form 01, Form 19, (Phase 02 and 04), Form 23

Data as of: September 1, 1997

Source of Data: UC Table 389A and 390A

Exhibit 38: Changes in Trough Dust Lead Loading (µg/ft 2) Between Phase 0 (12 Months Post-Intervention) and Phase 02 (Immediate Post-Intervention) fo Occupied Dwellings by Interior and Exterior Strategy Code





Note 1: Change represented by arithmetic mean dust lead loading from each dwelling at Phase 04 minus dwelling arithmetic mean at Phase 02.

Note 2: Interior Strategy Codes: 01=No Action, 02=Cleaning/Spot Painting, 03=02 + Full Painting, 04=03 + Window Treatment, 05=04 + Windows, 06=05 + Public Housing Standard, 07=Lead Free.
Exterior Strategy Codes: 00=No Action, 01=Partial Paint Stabilization, 02=Complete Paint Stabilization, Porch Treatments, 03=02 + Porch/Trim Enclosure and Stabilization, 04=All Lead Paint Enclosed or Removed, 05=All Lead Paint Removed.
See Exhibit 11 for detailed strategy definitions.

Data From: Form 01, Form 19, (Phase 02 and 04), Form 23

Data as of: September 1, 1997

Source of Data: UC Table 391A and 392A

The distribution of changes in dust lead loadings from Phase 02 to 04 on window sills across the spectrum of exterior strategies is fairly similar. Window sill dust lead loadings either declined or increased less than 26 μg/ft^2 in 44 percent of the dwellings for which exterior strategies were reported and increased more than 50 μg/ft^2 in 48 percent of those dwellings.

Window Troughs

The median change in window trough dust lead loadings at dwellings where treatment strategies were reported was an increase of between 501 and 800 μg/ft^2 from Phase 02 to Phase 04. As the level of interior treatments increase, a progressively smaller percentage of dwellings had window trough dust lead level increases of more than 500 μg/ft^2 (**Exhibit 38**). A progressively larger percentage of dwellings had either window trough dust lead level declines or increases of less than 400 μg/ft^2. Since there are differences in treatments to window troughs as the level of the strategy increases, these observations match expectations.

Like floors, dwelling units receiving no exterior treatments had a higher percentage of trough dust lead increases of more than 500 μg/ft^2 (75%) than dwellings in buildings with exterior treatments (50%). Also like floors, a *lower* percentage (36%) of dwellings where exterior strategy 03 was performed had trough dust lead increases greater than 500 μg/ft^2 than dwellings in buildings treated with exterior strategy 04 (48%). The possible relationship between exterior strategy 04 and changes in dust lead loadings is an area of further study.

Multivariate Statistical Models of Dust Lead Changes

This section presents early analyses of the effect of interventions on dust lead loadings using a multivariate statistical method called structural equations modeling. Structural equations modeling is used here to portray the relative influence of the multiple factors that could effect changes in dust lead levels through six months post-intervention. The modeling effort begins by identifying those factors which influence dust and paint lead levels prior to intervention. The impact of the intervention strategy may then be seen through the modification of the observed pre-intervention relationships and possibly in the creation of new relationships. This statistical approach will be continued throughout the analysis phase of the Evaluation as additional data become available.

A pre-intervention structural equation model for floor dust lead was used to identify those factors important in predicting dust lead loadings on interior entryways, interior floors, window sills and window troughs, as well as interior and exterior paint lead levels. These lead-based paint hazards are endogenous variables in the model, that is, the sources of their variation are determined by factors in the model. The factors considered which possibly influence each pre-intervention dust lead level include paint lead level and condition, building condition (e.g., deterioration of building components), other building characteristics (e.g., type of building, building age), family characteristics (e.g., type and frequency of cleaning), as well as dust lead levels from other applicable locations. All factors that are considered in the pre-intervention structural equation model are listed in **Exhibit 39**. As of September 1, 1997, complete data were available for the pre-intervention structural equation model from 808 dwelling units. The results of the modeling are presented in **Exhibit 40**.

Exhibit 39: List of Variables Used in Pre-Intervention Structural Equation Models

Lead Hazards
- Entryway Dust Lead
- Entryway Surface Condition
- Interior Floor Dust Lead
- Interior Floor Surface Condition
- Window Sill Dust Lead
- Window Sill Surface Condition
- Window Trough Dust Lead
- Window Trough Surface Condition
- Exterior Paint Lead
- Exterior Paint Condition
    - Interaction between Exterior Paint Lead and Condition
- Interior Paint Lead
- Interior Paint Condition
    - Interaction Between Interior Paint Lead and Condition

Building/Dwelling Condition
- Chimney Deterioration
- Exterior Walls or Siding Deterioration
- Foundation Deterioration
- Porch or Step Deterioration
- Roof, Gutter or Downspout Deterioration
- Window or Exterior Door Deterioration
- Interior Wall, Ceiling, Door, or Trim Deterioration
- Floor Deterioration
- Deterioration Caused by Plumbing Leak
- Deterioration Caused by Roof Leak

Other Characteristics
- Grantee
- Season
- Building Type
- House Age
- Ownership (Rent/Owned)
- Occupancy (Occupied/Vacant)

Household Characteristics
- Activities at Home (with potential lead exposure)
- Was Home Renovated
- Activities at Work (with potential lead exposure)
- Presence of a Broom
- Presence of an Electric Broom
- Presence of a Mop
- Presence of Sponges/Cloths
- Presence of a Vacuum
- How Often Furniture Dusted
- How Often Interior Window Sill Dusted
- How Often Interior Window Sill Washed
- How Often Floor Mopped
- How Often Floor Swept
- How Often Floor Vacuumed
- How Often Window Trough Washed
- Cleanliness of the Home
- Household Income
- Number of Children Less than 6 Years
- Number of People Between 6-18 Years at Home
- Number of Parents in Home

Child Characteristics*
- Child’s Blood Lead Level
- Child’s Age
- Child’s Age Squared
- Race of Child
- Sex of Child
- Child’s Mouthing Behavior
    - Interaction Between Entry Dust Lead and Mouthing
    - Interaction Between Interior Floor Dust Lead and Mouthing
- Number of Hours Awake per Week
- Number of Hours Away from Home per Week
- Number of Hours Inside the House per Week
- Number of Hours Outside the House per Week
- Child Received WIC Benefit (w/i 3 months)
- Years of Education of Father
- Length of Residency of Child

* Child Characteristics Only included in Blood Model

A factor was considered important (or significant) in the model if there was a 95 percent probability that the factor had a direct effect on the paint or dust lead value. For instance, interior floor dust lead levels were directly affected by 1) entryway dust lead levels, 2) the "grantee effect" (discussed below), 3) building type, 4) condition of interior painted surfaces, 5) the surface condition of the entry floor, 6) whether a vacuum cleaner was present in the dwelling, 7) the year the dwelling was built, 8) an interviewer rating of general cleanliness of the dwelling, and 9) the presence of deterioration of the exterior porch or steps. In comparison, window trough dust lead levels appeared to respond directly only to paint lead levels on exterior painted surfaces, the condition of the trough surface, and the "grantee effect".

One variable in the model that had a significant, direct influence on all of the paint and dust lead variables was the "grantee effect". The "grantee effect" represents unique factors at each grantee site (both environmentally and programmatically) that may explain variation in paint and dust lead levels beyond the other variables in the model. There are many factors that may vary by grantee (i.e., differences in dwelling selection, soil lead levels, etc.) which are not currently in the model that could influence paint or interior dust lead levels. Some of these factors may be able to be tested later if data become available to assess them. The influence of soil lead could be tested for those dwellings where the grantee chose to sample soil. Of course, there will be other factors represented by the "grantee effect" which cannot be independently explained because data for those factors will not have been collected.

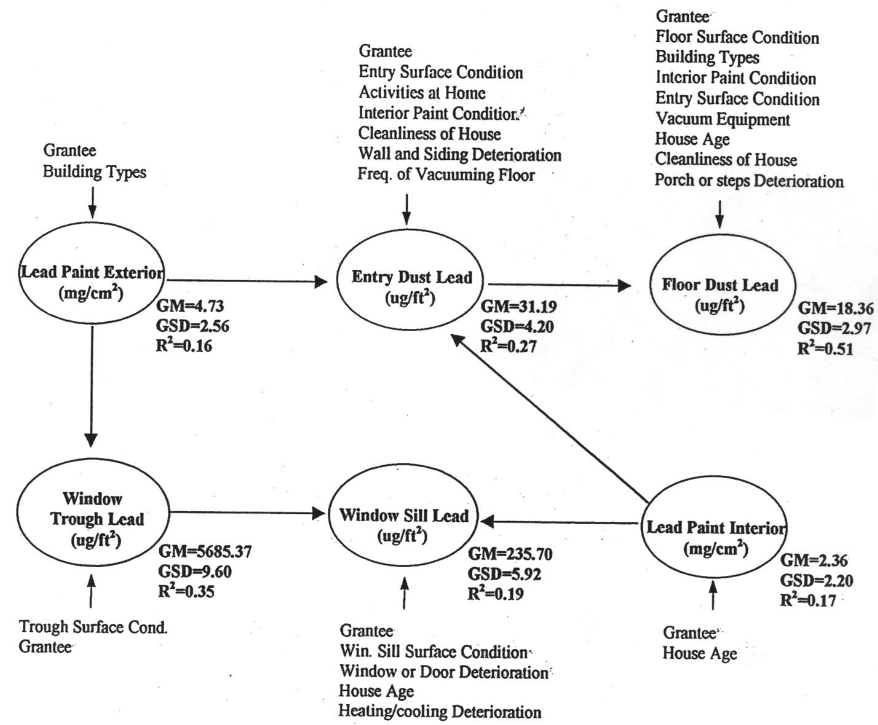
The model also illustrates factors that were indirectly related to dust lead levels. For example, both interior and exterior paint lead levels indirectly affected Phase 01 interior floor dust lead levels by directly affecting entryway floor dust lead loadings. Building type had an indirect effect on all four dust lead locations through its relationship with exterior paint lead levels. A more detailed explanation of the structural equation modeling procedure and these results is found in the Compendium of Tables associated with this report.

Using the pathways identified as significant in the pre-intervention floor dust lead model, the impact of the intervention on six month post-intervention dust lead levels was examined. Complete data were available for an analysis of the six-month post intervention data from 367 dwellings. This analysis investigated the possible influence of the lead hazard control intervention on the relationships between pre-intervention environmental lead measures and six month post-intervention dust lead levels.

The intervention strategy, the cost of the intervention, and the total project cost were factors used to describe the intervention in the model. The intervention strategy was characterized by its intensity and location, separate variables being included for interior, exterior, and site strategies. Cost was included as a way of estimating variations in intensity or nature of work beyond that captured by the strategy levels. The total project cost was included to try to capture the possible impact of non-lead related work (e.g., leak repairs, general painting, etc.) on Phase 03 dust lead levels.

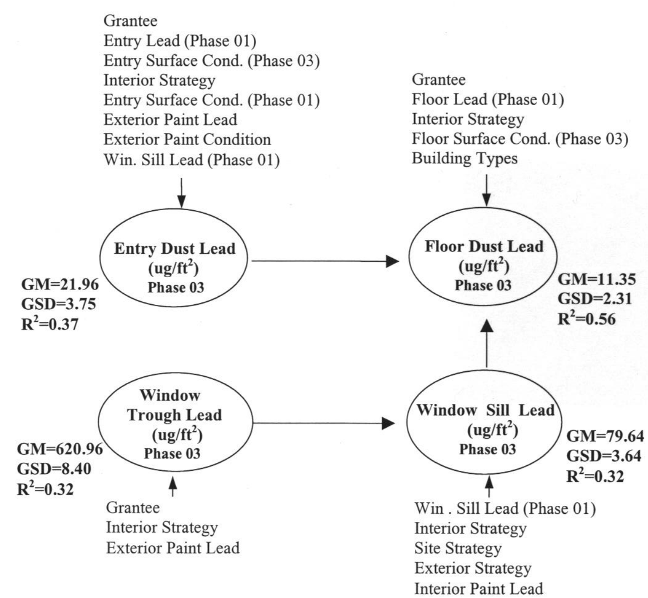
Interior strategy had a significant effect on Phase 03 dust lead levels at all four of the dust sample locations (**Exhibit 41**). Exterior strategy had a direct effect on window sill and trough dust lead levels only, while site strategy had a direct effect on just window sill dust lead. It is interesting to note, however, that window sill dust lead levels did not have an effect on interior

Exhibit 40: Pre-Intervention Floor Dust Lead Pathway
(808 Dwelling Units Analyzed)



Note: Solid line indicates that a statistically significant coefficient was found.
All coefficients are significant at $P<0.05$
Data from : Forms 01, 04, 10-11, 14-16, 19 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC SEM Figure 2

Exhibit 41: Six-Month Post-Intervention Floor Dust Lead Pathway (367 Dwelling Units Analyzed)



Note: Solid line indicates that a statistically significant coefficient was found.
All coefficients are significant at $P<0.05$
Data from: Forms 01, 04, 10, 11, 14-16, 19 (Phase 01 & 03) and 23
Data as of: September 1, 1997
Source of Data: UC SEM Figure 4

floor dust lead levels at Phase 01 (see **Exhibit 40**), but they did affect Phase 03 levels. This suggests that exterior and site strategies had indirect effects on interior floor dust lead loadings. Neither lead hazard control costs nor total project costs significantly affected post-intervention dust lead levels when strategy was included in the model. This finding suggests that costs do not contribute additional information beyond what is captured by the strategy variable.

Another finding of the six month post-intervention model was that Phase 03 dust lead levels on interior floors, entryways, and window sills were related to the baseline levels on those surfaces. Only window troughs did not display this same relationship. The relationship between Phase 01 and Phase 03 dust lead levels was somewhat unexpected, since contractors were required to reach a fixed dust lead standard at clearance, presumably creating fairly equal dust lead levels across dwellings. The model may indicate that baseline dust lead levels are representative of the lead exposure sources at the dwellings or in the nearby environment which were not addressed or only partially addressed by the intervention strategies.

A structural equation model of dust lead levels twelve months after the intervention is beginning to be developed. Overall, the pattern is not substantially different from the six-month model. However, it is based on 305 dwelling units and must be considered very preliminary. These preliminary results are displayed in the Compendium of Tables.

VI. Changes in Blood Lead Levels

When the Evaluation was designed, it was recognized that there are some important limitations to using children's blood lead levels as a measure of lead hazard control effectiveness. Lead can enter a child's blood stream from many sources beyond those affected by the environmental interventions funded by HUD. Blood lead levels can also be affected by the child's nutrition, and have been found to vary with the age of the child and the season of the year. The introduction to the Evaluation study design protocols further noted that,

> "Finally, chronically lead-poisoned children may continue to have elevated blood lead levels for months or years after exposure has ceased due to body stores that usually decline very slowly. Thus, monitoring changes in blood lead levels after environmental intervention may underestimate the primary preventive benefit of exposure reduction in a treated dwelling from birth onward. For this reason, the most important outcome measure for this evaluation will be changes in dust lead loading in dwellings undergoing environmental intervention."

Despite these limitations, blood lead data, in conjunction with data on changes in environmental conditions in dwellings, are relevant and useful outcome measures. As with dust lead loading, changes over two intervals are of interest: 1) short term changes from pre-intervention (Phase 01) to six weeks post intervention (Phase 02) and 2) longer term changes from pre-intervention to six months (Phase 03) and 12 months (Phase 04) post-intervention. While reductions in blood lead levels in chronically lead exposed children would not be expected in the first several weeks after lead hazard reduction measures, short term increases could reflect some deficiency in work practice, containment, cleanup, and clearance measures. An assessment of the short term blood lead changes has been prepared for this interim report. Over the longer term, changes in household lead exposure should be reflected in blood lead level changes. This report presents preliminary results for the long term changes in blood lead from Phase 01 to Phase 03 and Phase 01 to Phase 04.

Seasonal and Age Adjustments of Blood Lead Levels

Previous studies have observed that a child's blood lead is likely to vary by the annual cycle of seasons and by the age of the child. The exact pattern and amount of variation has differed from study to study, but the tendencies were similar. Blood lead levels tend to be lower in very young children, rise until around the age 1-2 and then begin to decline. On an annual basis, blood lead levels tend to peak in the summer months and reach their lowest point in the winter months. Reasons for these patterns are not clear, but they are hypothesized to be a combination of biological and behavioral changes of the maturing child and biological and exposure changes that occur over the course of a year.

Pre-intervention blood lead levels were analyzed to see if these patterns held true in the Evaluation. Patterns similar to those found in previous studies were identified. Children's blood lead levels rose between the age of six months and 19 months, peaked between 19 months and 36 months and then declined (**Exhibit 42**). Blood lead levels rose and fell on an annual cycle, with a peak in July and a nadir in January. From peak to nadir, the semi-annual change at the median blood lead level was approximately 1.5 μg/dL (micrograms/deciliter).

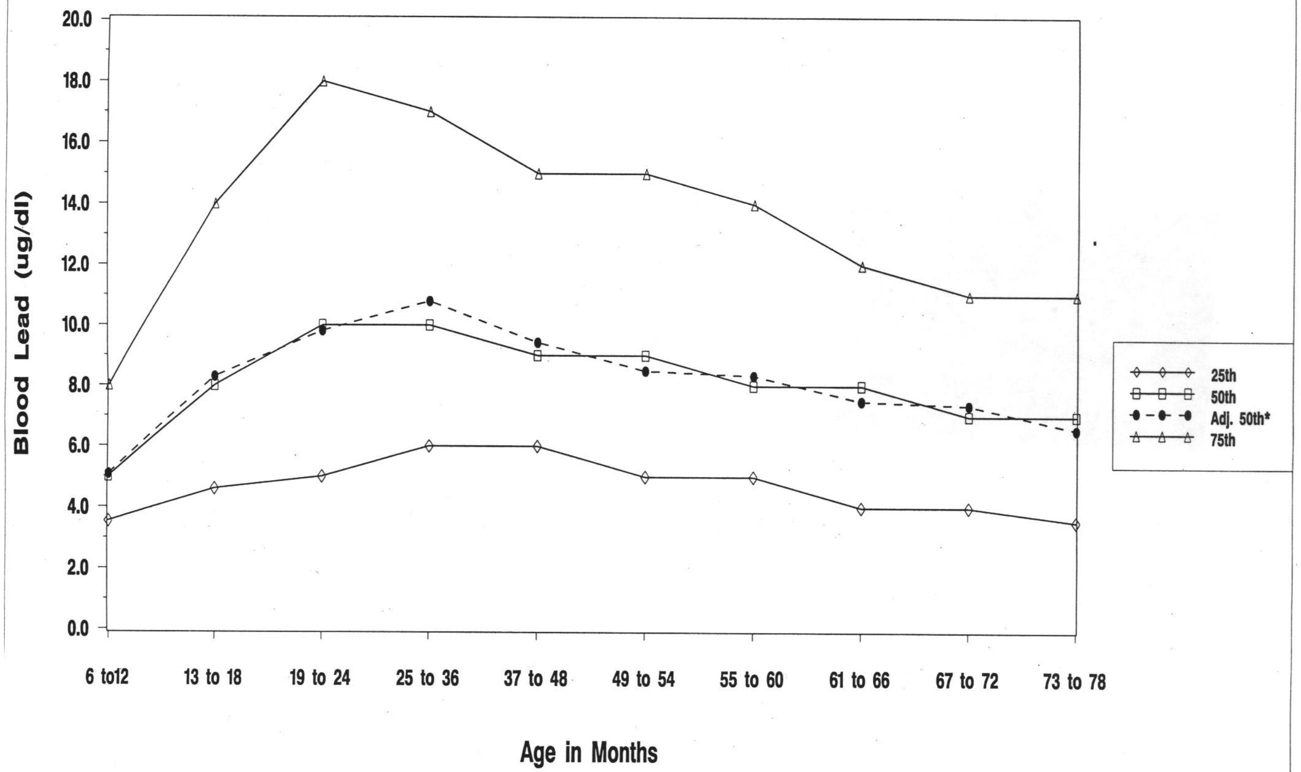
For presentations of changes in blood lead levels, blood lead changes have been adjusted to reflect the expected changes due to time of year (season) and age (**Exhibit 43 and 44**). By adjusting the blood lead levels, interventions are not unjustifiably credited or penalized for changes that would have been expected because of these factors. (Currently, the adjustment for age is relatively flat and does not display the increase in blood lead levels for the youngest children that appears on other tables. The adjustment will be examined further for later reports. The current adjustment may underestimate the effect of the treatments for the youngest children (about 15% of the population).

Detection Limits

Like environmental laboratories, laboratories that analyze blood for lead report different detection limits. Six of the grantees participating in the Evaluation reported some blood lead results that fell below the limit of detection. Limits of detection ranged from 1 to 5 μg/dL. As with dust lead results, blood lead results that fell below the limit of detection are reported as a value of one divided by the square root of two multiplied by the reported value. Thus, a value reported as at or below the level of 5 μg/dL would be reported as 3.5 μg/dL.

For the roughly four to five percent of blood lead results that fell below the detection limits, the analyses presented in this report may be affected in several ways. First, a baseline result that begins at the limit of detection cannot display a decline. Second, a value of five that increases to 6.5 μg/dL would be considered within the range of measurement error. However, when reported by a lab with a detection limit of 5 μg/dL, the change could appear to be a significant increase (3.5 to 6.5 μg/dL). On the positive side, with less than five percent of the results at or below detection limits, these effects are likely to have less impact on the analyses than the effects of the dust lead detection limits.

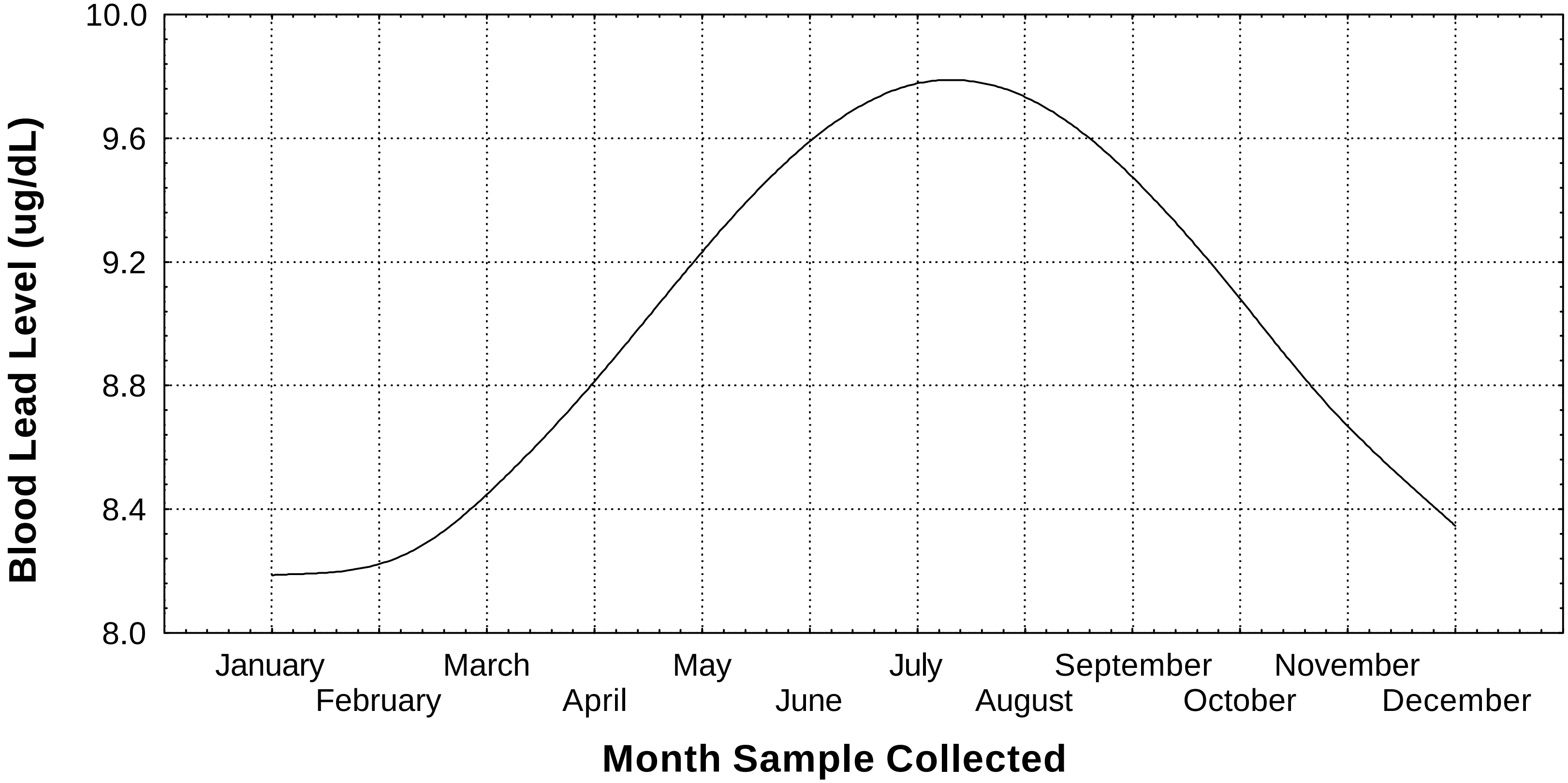
Exhibit 42: Unadjusted Pre-Intervention Blood Lead Levels by Age of Child



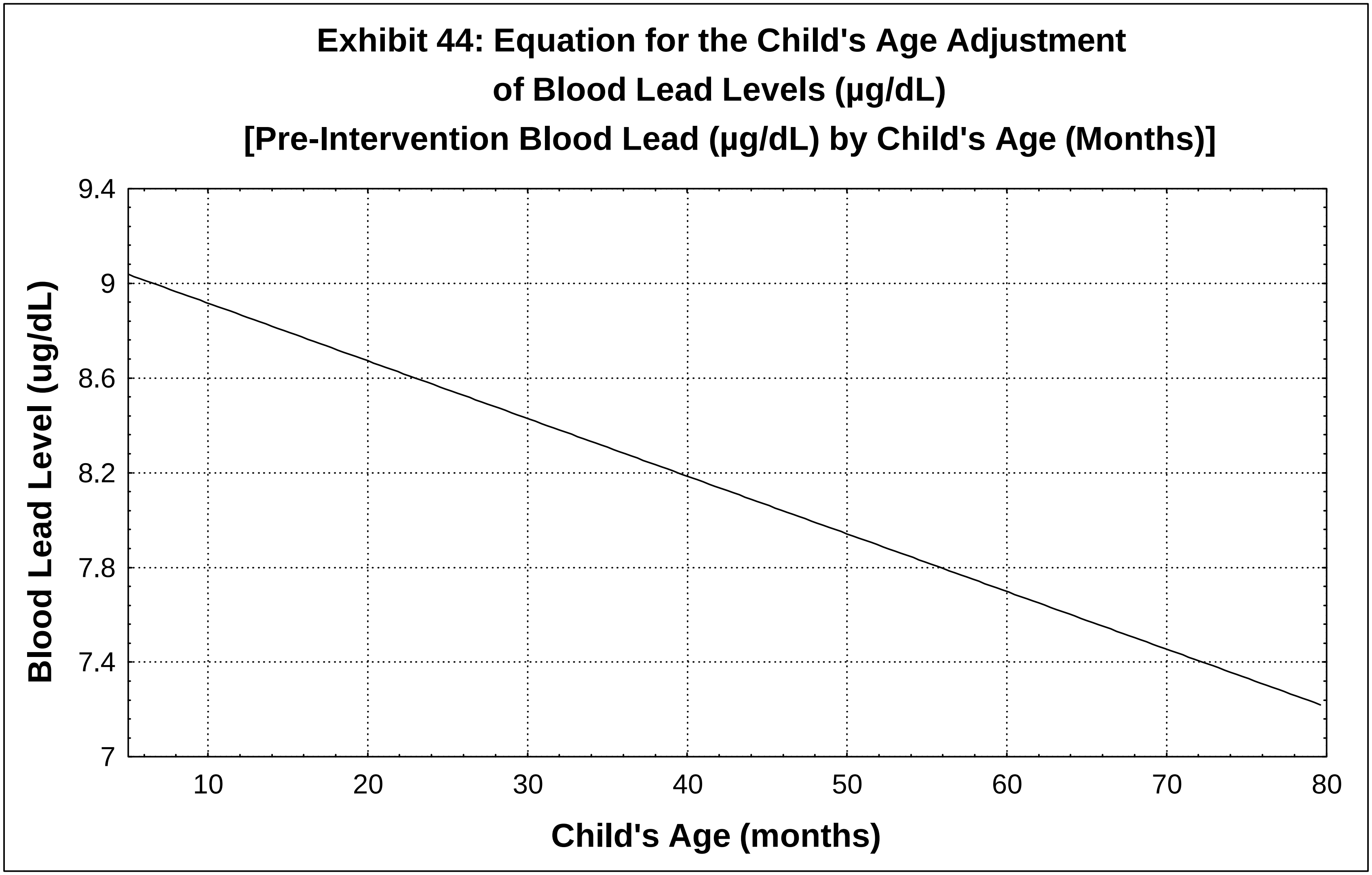
Data from : Form 01, Form 09
Data as of: September 1, 1997
Source of Data: UC Figure

* Blood Lead Levels adjusted by season

Exhibit 43: Equation for the Seasonal Adjustment of Blood Lead Levels (µg/dL) [Pre-Intervention Blood Lead (µg/dL) by Month Sample Collected]



Equation Fit: ln(Bpb) = 2.19 - 0.07*sine - 0.06*cosine
Data from: Form 04 (Phase 01), Form 09 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Table 296 ADJ-1



Equation Fit: ln(Bpb) = 2.22-0.003*Child's Age
Data from: Form 04 (Phase 01), Form 09 (Phase 01)
Data as of: September 1, 1997
Source of Data: UC Table 296 ADJ-2

Increases in Blood Lead Observed after Intervention

HUD stipulated that grantees design interventions in a manner that would protect the occupants and prevent their exposure to lead that was made more available during the process of intervention. Previous research has indicated that large increases in blood lead can occur as a result of lead abatement activities unless very special precautions are taken. These precautions include keeping the child away during the intervention process and thorough cleaning after the intervention and before reoccupancy. Very detailed guidance regarding the need for appropriate relocation was provided to the grantees. Post-intervention cleaning is monitored by numerous clearance dust samples taken after intervention work and cleaning have occurred. As a means of monitoring possible unintended exposure of a child **during** intervention, a blood lead sample is collected within six weeks after the completion of intervention and clearance. In addition, an "occupant protection" questionnaire is administered to learn of the household's experiences during the intervention period (i.e., where they were relocated, whether they returned to the home during intervention, etc.).

As of May 1, 1997 about ten percent (71 out of 685) of the children for whom both pre-intervention (Phase 01) and within six weeks following intervention (Phase 02) blood lead data were available experienced blood lead increases of 5 μg/dL or greater. Nine grantees had at least one child with such an increase. Five μg/dL was selected because it is considered an increase that is greater than expected laboratory variation. On two occasions, grantees have been asked to examine the cases of increases of 5 μg/dL or more and to indicate possible reasons for the increase. A form for indicating the responses contained a list of possible reasons and for an "other" response to be specified. Thus far information has been received from seven grantees for a total of 54 children out of the 71 for whom increases have been observed.

In addition to exposure to the lead dust created during the intervention process, there are a number of other possible reasons for the increases. Children may be exposed to lead hazards outside the home, such as at another residence where the child may spend some time, or to non-housing related exposures within the home, such as parental hobbies or work activities and folk remedies. Seasonal and age variation can also explain some blood lead increase. The net seasonal difference among children involved in the Evaluation was an increase of 1.5 μg/dL from the month of lowest blood lead values to the month of highest blood lead values. The net difference between a 6 to 12 month old child and a 13 to 18 month child in the study was an increase of 3.0 μg/dL.

Assessing the possible reasons for the blood lead increase from Phase 01 to Phase 02 is one of the specific objectives of the evaluation. A review of responses received to date indicate that for four of the 51 children, an exposure to the intervention process was suggested as a possible reason for the increase. For each of these four children, the relocation was judged to be incomplete. These four children represent less than one percent of the 685 children for whom pre-intervention blood lead data was available. In one case, the intervention was performed room by room with the rooms still occupied by the family being sealed off from the rooms undergoing intervention. Based on the observed blood lead increase, the grantee discontinued the practice of allowing the family to stay in the home. In another case, the family returned home to sleep in the house, another visited the house during the intervention and the fourth remained at home during the exterior intervention which involved efforts to isolate the intervention work from the family.

Further analysis of the information concerning these observed blood lead increases is underway and will involve comparing responses in the Occupant Protection form with the other data received and determining how many other children may have had "partial" or "incomplete" relocation.

<u>Changes From Pre-Intervention (Phase 01) To Six and Twelve Months Post-Intervention (Phases 03 and 04)</u>

When blood lead levels are measured repeatedly in any child, small variations from one test to the next are expected, even if no systematic change in the child's environment has occurred. Such changes reflect the small amount of random error inherent in a blood lead measurement, as well as day to day changes in a child's behavior patterns, play locations, and diet. For this preliminary presentation of results, blood lead changes of 3 µg/dL or less in either direction are considered to essentially represent no meaningful change for individual children. **Exhibits 45 and 46** show the proportion of children who have had "no change" in adjusted blood lead levels and the proportions with small (> 3 µg/dL to 6 µg/dL) or larger (> 6 µg/dL) decreases or increases in blood lead.

Change from Pre-intervention to Six Months

As of September 1, 1997, Phase 01 and Phase 03 blood lead data have been reported for 541 children (**Exhibit 45**). Overall, almost five times as many children had decreases of more than 3 µg/dL (34%) than had increases of that amount (7%). For changes of more than 6 µg/dL, there were also more decreases (16%) than increases (4%).

Fifty-nine percent of children had an absolute change of less than 3 µg/dL in adjusted blood lead level over the interval. As noted previously, a small percentage of these children may have blood lead levels that changed, but the change was not detectable by the laboratory. More importantly, nearly (24%) of the baseline blood lead levels were less than 5 µg/dL. At these levels, a decline in blood lead levels of 6 µg/dL is obviously impossible and a decline of 3 µg/dL is less likely for children with such low blood lead levels.

Across grantees, there is some variation in the changes in blood lead levels. For three grantees, Cleveland, Milwaukee and Minnesota, more than 40 percent of their children had declines of more than 3 µg/dL, while in Rhode Island, 35 percent of the children had a decline of 3 µg/dL or more. For all other grantees with at least 20 children tested in Phase 01 and 03, no more than 26 percent of the children had declines of 3 µg/dL or more. The difference between the two sets of grantees may be related to the initial blood lead levels of the children. The four grantees with the largest declines in blood lead levels were more likely to enroll children with blood lead levels at or above 20 µg/dL; at least 16 percent of the children at each site were above that level. Of the other grantees, eight percent or less of the children had blood lead levels above 20 µg/dL at any particular site. The possibility that the magnitude of the initial blood lead levels affects the change in levels will have to be monitored in later analyses.

Exhibit 45: Change in Children's Blood Lead Levels (ug/dl) Pre-Intervention to Six Months Post-Intervention for Samples Reported in Both Phases (All Blood Results Age and Seasonly Adjusted)

(Grantee specific data shown when at least 20 dwelling units submitted)

Grantee	Change in blood lead (Six months Post-Intervention minus Pre-Intervention)					
	< -6	< -3 to -6	-3 to 3	> 3 to 6	> 6	Total children
Baltimore	1	3	39	1	1	45
	2.2%	6.7%	86.7%	2.2%	2.2%	100.0%
Boston	2	4	20	1	1	28
	7.1%	14.3%	71.4%	3.6%	3.6%	100.0%
Cleveland	10	7	15	2	1	35
	28.6%	20.0%	42.9%	5.7%	2.9%	100.0%
Massachusetts	6	8	35	3	3	55
	10.9%	14.5%	63.6%	5.5%	5.5%	100.0%
Milwaukee	31	33	54	2	9	129
	24.0%	25.6%	41.9%	1.6%	7.0%	100.0%
Minnesota	25	17	47	5	3	97
	25.8%	17.5%	48.5%	5.2%	3.1%	100.0%
Rhode Island	1	6	11	1	1	20
	5.0%	30.0%	55.0%	5.0%	5.0%	100.0%
Vermont	5	3	22	2	1	33
	15.2%	9.1%	66.7%	6.1%	3.0%	100.0%
Wisconsin	2	13	55	0	0	70
	2.9%	18.6%	78.6%	0.0%	0.0%	100.0%
All Grantees:	86	95	321	19	20	541
	15.9%	17.6%	59.3%	3.5%	3.7%	100.0%

Data from: Form 09 (Phase 01 and 03).

Data as of: September 1, 1997.

Source of Data: UC Table 296-ADJ.

Exhibit 46: Change in Children's Blood Lead Levels (µg/dl) Pre-Intervention to Twelve Months Post-Intervention for Samples Reported in Both Phases (All Blood Results Age and Seasonly Adjusted)

(Grantee specific data shown when at least 20 dwelling units submitted)

Grantee	Change in blood lead (Twelve months Post-Intervention minus Pre-Intervention)					
	< -6	< -3 to -6	-3 to 3	> 3 to 6	> 6	Total children
Baltimore	0	2	19	2	0	23
	0.0%	8.7%	82.6%	8.7%	0.0%	100.0%
Boston	3	6	10	1	0	20
	15.0%	30.0%	50.0%	5.0%	0.0%	100.0%
Cleveland	7	7	8	0	0	22
	31.8%	31.8%	36.4%	0.0%	0.0%	100.0%
Massachusetts	6	4	14	1	1	26
	23.1%	15.4%	53.8%	3.8%	3.8%	100.0%
Milwaukee	23	27	40	2	5	97
	23.7%	27.8%	41.2%	2.1%	5.2%	100.0%
Minnesota	25	16	28	4	0	73
	34.2%	21.9%	38.4%	5.5%	0.0%	100.0%
Wisconsin	2	9	27	0	0	38
	5.3%	23.7%	71.1%	0.0%	0.0%	100.0%
All Grantees:	72	80	168	12	6	338
	21.3%	23.7%	49.7%	3.6%	1.8%	100.0%

Data from: Form 09 (Phase 01 and 04).

Data as of: September 1, 1997.

Source of Data: UC Table 344-ADJ.

Change from Pre-intervention to Twelve Months

After one year, the decline in blood lead levels appear to be even stronger than after six months. Of the 338 children whose blood was tested at both Phase 01 and 04, 45 percent of the children experienced a decline of more than 3 μg/dL and five percent experienced an increase of 3 μg/dL or more (after adjusting for age and season) (**Exhibit 46**). Large changes were just as dramatic, with a ten-fold difference between the percentage of children that had decreases of more than 6 μg/dL (21%) as opposed to increases of that amount (2%).

Part of the overall change could be partially explained by the higher ratio of children from the four grantees more likely to enroll lead poisoned children (61% of the Phase 01/04 total vs. 52% of the Phase 01/03 total), but it does not totally explain the changes. Of the seven grantees that submitted blood lead results for at least 20 children tested in Phase 01 and Phase 04, all but Baltimore had a larger percentage of blood lead results that declined and a smaller percentage that increased. In Baltimore, where children were less likely to exhibit any significant change, the change in blood lead levels from Phase 01 to Phase 03 was similar to the change from Phase 01 to Phase 04.

Although blood lead levels appear to be much less likely to decline in Baltimore than at any other grantee site (9% vs. 29% in Wisconsin), the lack of change may reflect the relatively low initial blood lead levels of the enrolled children in Baltimore. When blood lead changes were compared by percent change from Phase 01 to Phase 04 (**Exhibit 47**), Baltimore is much more similar to other grantees.

Overall, almost five times as many children had declines of more than 20 percent than increases of that amount (57% to 12%). Changes of 50 percent or more were more comparable, with 12 percent of the blood leads declining and eight percent increasing by that percentage. Besides Baltimore, Wisconsin and Milwaukee also tended to have more children with declining blood leads than increasing blood leads when compared on a percentage basis. Interestingly, Massachusetts did not appear to perform as well when blood lead levels are compared by percent change. All of these results must be viewed with some caution, however, since up to 19 percent of the children whose blood lead levels rose or fell more than 20%, had an absolute change within the measurement error of 3 μg/dL.

<u>The Effect of the Interventions on Blood Lead Changes</u>

The HUD Lead Hazard Grant Program was undertaken with the expectation that successful interventions would result in declines in blood lead levels. Furthermore, the Evaluation was undertaken to see if particular classes of treatments (and possibly even specific treatments) could be judged to be more or less effective at reducing blood lead levels. However, as stated earlier when discussing the effect of interventions on dust lead loadings, it must be recognized that there have been many other factors that are occurring to the environment of the children in the Evaluation that could affect blood lead levels. To explain how these other factors affect blood lead levels, multivariate statistical analyses have been conducted. Yet at the same time, simple descriptive figures have been prepared that examine changes in blood lead levels from Phase 01 to Phase 03 of children living in dwellings treated with different interior strategies. Initial expectations are that higher level strategies will have greater effects on blood lead levels than lower level treatments.

Exhibit 47: Percent Change in Children's Blood Lead Levels (µg/dl) Pre-Intervention to Twelve Months Post-Intervention for Samples Reported in Both Phases (All Blood Results Age and Seasonly Adjusted)

(Grantee specific data shown when at least 20 dwelling units submitted)

Grantee	Percent Change in blood lead (Twelve months Post-Intervention minus Pre-Intervention)					
	< -50%	< -50 to -20%	-20% to 20%	> 20 to 50%	> 50%	Total children
Baltimore	0	12	9	0	2	23
	0.0%	52.2%	39.1%	0.0%	8.7%	100.0%
Boston	0	11	7	1	1	20
	0.0%	55.0%	35.0%	5.0%	5.0%	100.0%
Cleveland	2	10	8	2	0	22
	9.1%	45.5%	36.4%	9.1%	0.0%	100.0%
Massachusetts	2	9	6	3	6	26
	7.7%	34.6%	23.1%	11.5%	23.1%	100.0%
Milwaukee	15	46	24	3	9	97
	15.5%	47.4%	24.7%	3.1%	9.3%	100.0%
Minnesota	12	33	19	3	6	73
	16.4%	45.2%	26.0%	4.1%	8.2%	100.0%
Wisconsin	2	15	21	0	0	38
	5.3%	39.5%	55.3%	0.0%	0.0%	100.0%
All Grantees:	40	151	105	16	26	338
	11.8%	44.7%	31.1%	4.7%	7.7%	100.0%

Data from: Form 09 (Phase 01 and 04).

Data as of: September 1, 1997.

Source of Data: UC Table 375

Exhibit 48 displays a comparison of the changes in blood lead levels from Phase 01 to Phase 03 by interior strategy. Like the descriptive figures that present dust lead changes by strategy, this figure not only ignores other factors that could affect blood lead changes, but also ignores the possible interactions between the interior/exterior/site strategies and concurrent work.

Granting these limitations, as the intensity of the work increases between interior strategy 02 and 04, the percentage of blood lead levels that decline by more than 3 μg/dL also increases. Twenty-nine percent of children in homes treated with interior strategy 02 (cleaning and possibly spot painting) had adjusted blood lead declines of at least 3 μg/dL, while 44 percent of children in homes treated with interior strategy 04 (paint stabilization and window treatments) had adjusted blood lead declines of the same magnitude. This observed trend stops, however, at interior strategy 05. It is possible that there are some grantee differences that might explain the results. Milwaukee and Minnesota, where children's blood lead levels were more likely to decline at Phase 03, conducted more treatments below strategy level 05. Meanwhile, Baltimore, Boston, and Wisconsin with the smallest percentage of declining blood lead levels, conducted interior strategy 05 in over two-thirds (71%) of their units. Such a combination of grantee factors could make it appear that interior strategy 05 is not as successful, when alternatively, the grantees who conducted the higher level strategy enrolled children with low initial blood lead levels that would not decline significantly, even with the additional work. Certainly, such interactions warrant further review.

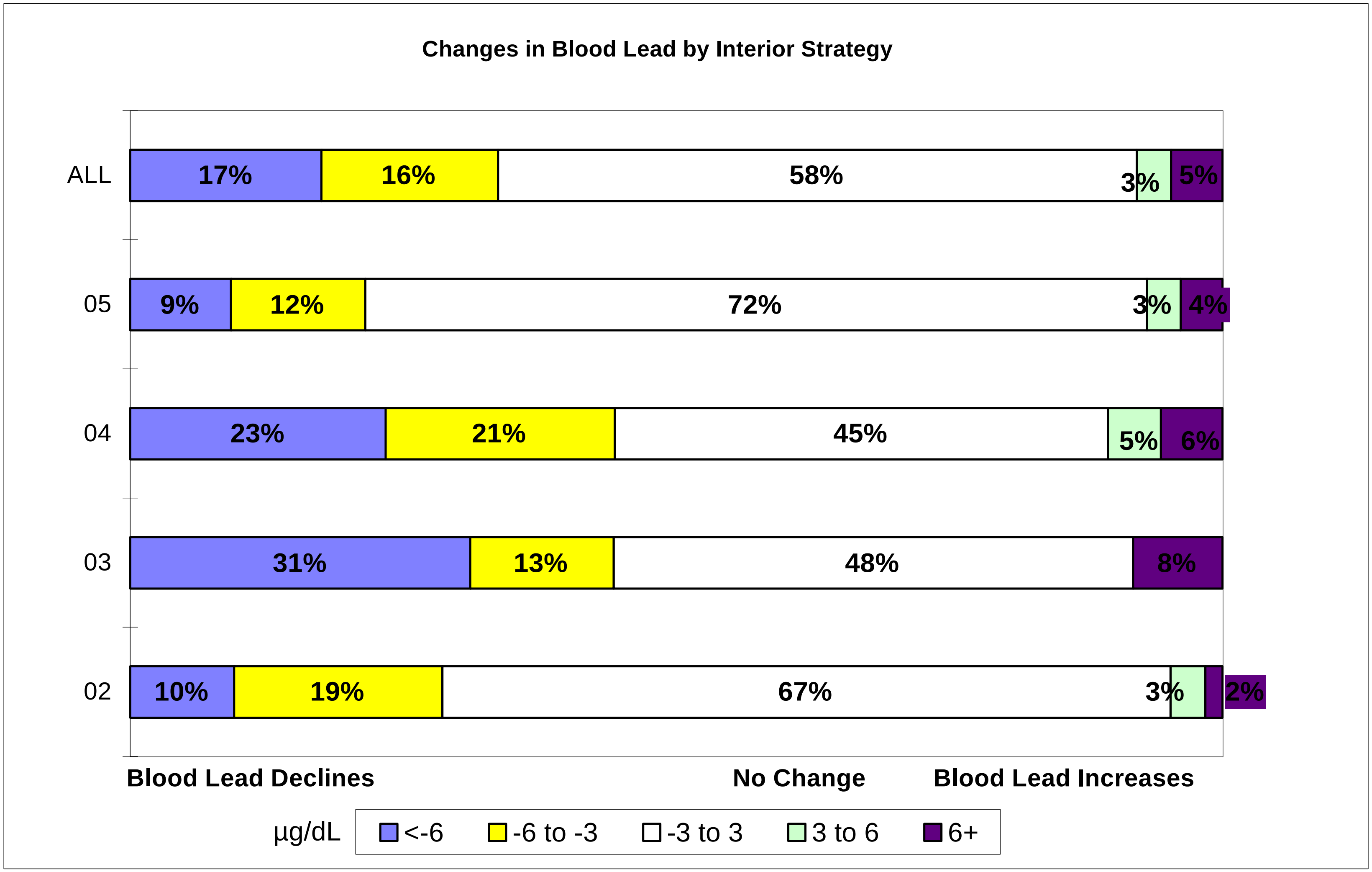
Multivariate Statistical Models of Blood Lead Changes

This section presents the results of preliminary structural equation models which were developed to help explain the effectiveness of lead hazard control activities in reducing children's blood lead levels and maintaining that reduction. Like the analyses of changes in dust lead levels, the multivariate statistical method of structural equation modeling was used to address the multiple factors that may influence a child's blood lead level. Children's blood lead levels have been shown to be related to familial and personal characteristics and behaviors as well as to their physical environment.

Like the structural equation analyses of post-intervention dust lead, the analysis of blood lead changes begins with a pre-intervention model which identifies relationships which exist and might change as a result of a physical intervention. The list of variables considered in this analysis includes all of variables used in the floor dust lead model and an additional 15 variables related to the child (**Exhibit 39**). For statistical reasons, only the youngest child in a dwelling was included in the analysis. After other restrictions were applied, the analysis of baseline conditions included 459 children and dwellings. (A description of the other restrictions is found in the Compendium of Tables associated with this report.)

Certain environmental factors were found to have a significant direct relationship with children's pre-intervention blood lead levels, including interior floor dust lead loadings and interior paint lead levels (**Exhibit 49**). Other factors that were also found to be directly related to blood lead levels included age of the child, family income, the number of people in the household between six and 18 years of age, season of the year, and the "grantee effect" (discussed on page 82). Thirty-two percent of the variation ($R^2 = 0.32$) in pre-intervention

Exhibit 48: Changes in Adjusted Blood Lead Between Phase 03 (Six-Month Post-Intervention) and Phase 01 (Pre-Intervention) by Interior Strategy Code



Note: Interior Strategy Codes: 01=No Action, 02=Cleaning/Spot Painting, 03=02 + Full Paintin(

04=03 + Window Treatment, 05=04 + Windows, 06=05 + Public Housing Standard, 07=Lead Free.

See Exhibit 11 for detailed strategy definitions.

Data from: Form 09 and Form 23

Data as of: September 1, 1997

Source of Data: UC Table 338-ADJ

blood lead levels were explainable by the model. The single most important factor was the "grantee effect", which explained nine percent of the variation in blood lead level. The most important environmental variable was interior paint lead levels which explained three percent. These detailed statistics are found in the Compendium of Tables.

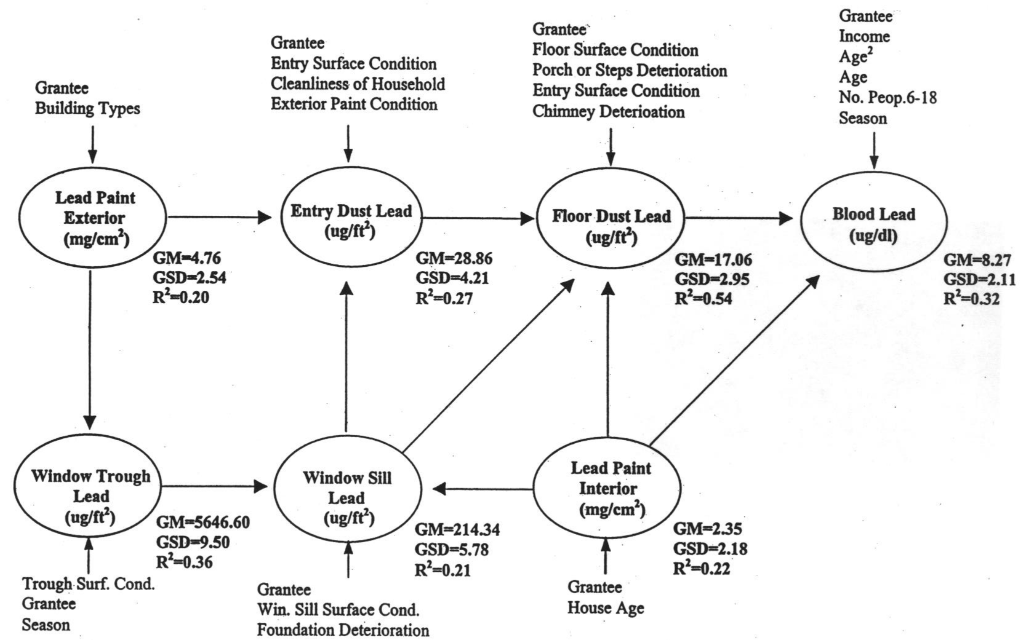
As expected, factors that influenced environmental lead levels on the path toward a child's blood lead level were similar to those factors identified in the pre-intervention structural equation model for floor dust lead (**Exhibit 40**). Because the blood model includes additional variables and a smaller sample of dwelling units, some relationships were identified that differed from the dust model. Among the factors that changed, window sill dust lead levels and interior paint lead levels were found to exhibit significant direct influences on floor dust lead levels in the blood lead model but not in the floor dust lead model. Window sill dust lead levels, which did not influence any other variable in the pre-intervention floor dust lead model, were also directly related to entryway floor lead levels. Interior paint lead was not significantly associated with entry floor lead levels. These differences do not radically change the pathways identified, but they underscore the point that as sample sizes increase and different variables are included, these models are expected to undergo some changes.

The impact of the intervention on six month post-intervention blood lead levels was then examined using the pathways considered significant in the pre-intervention blood lead model. The analysis investigated relationships between pre-intervention and post-intervention environmental and blood lead measurements mediated by the intervention itself. As in the floor dust lead model, the intervention was described using the intervention strategy, the cost of the intervention, and the total project cost. As of September 1, 1997, data for 265 children and their dwellings were available for the analysis (**Exhibit 50**).

Six months after the intervention, arithmetic mean blood lead levels were 2.4 μg/dL below pre-intervention levels; geometric mean blood lead levels declined by 1.5 μg/dL. In the model, pre-intervention blood lead levels explained about 37 percent of the variation in Phase 03 blood lead levels. (See detailed statistical tables found in the Compendium of Tables.) In other words, a child whose blood lead level was relatively higher in Phase 01 would be expected to remain relatively higher in Phase 03. This finding is generally consistent with previous findings showing strong relationships between serial blood lead tests in an individual child. Other factors that were significantly associated with Phase 03 blood lead levels included the child's race, the number of residents between 6 and 18 years of age, the "grantee effect", and the exterior strategy.

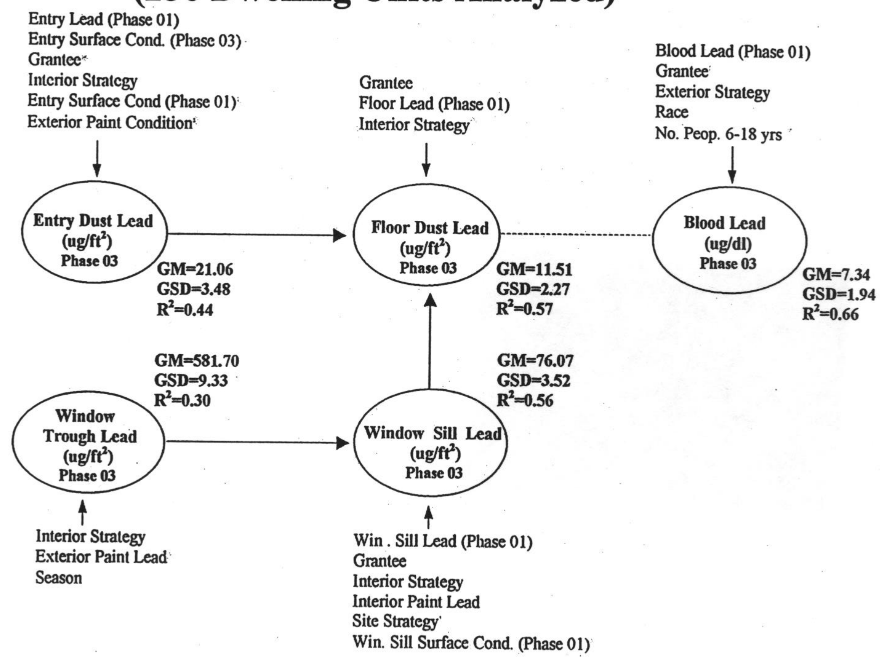
Six-month blood lead levels were directly related to pre-intervention blood lead levels which in turn, were directly affected by pre-intervention dust and paint lead. Of interest, Phase 03 blood lead levels were not found to be directly related to either Phase 03 dust lead levels or to Phase 01 dust lead levels. This finding suggests that the pathway between dust lead and blood lead was broken following the intervention. A possible explanation for this finding is that six months after the intervention, the lead hazard control activities reduced dust lead levels to a point where they were no longer a significant contributor to the child's blood lead levels. Given the potential importance of this finding, it must be emphasized that these findings are preliminary, like all of the findings in this report.

Exhibit 49: Pre-Intervention Blood Lead Exposure Pathway (459 Dwelling Units Analyzed)



Note: Solid line indicates that a statistically significant coefficient was found.
All coefficients are significant at $P<0.05$
Data from : Forms 01, 04-05, 0-11, 14-16, 23 and 09 and 19 (Phase 01 & 03)
Data as of: September 1, 1997
Source of Data: UC SEM Figure 1

Exhibit 50: Six-Month Post-Intervention Blood Lead Exposure Pathway (256 Dwelling Units Analyzed)



Note: Solid line indicates that a statistically significant coefficient was found.
All coefficients are significant at $P<0.05$
Data from : Forms 01, 04-05, 0-11, 14-16, 23 and 09 and 19 (Phase 01 & 03)
Data as of: September 1, 1997
Source of Data: UC SEM Figure 3

As in the floor dust lead model, interior strategy was found to have a significant influence on dust lead levels at all four locations. Site strategy was related to window sill dust lead levels. Unlike the floor dust lead model, exterior strategy was not significantly related to the window sill or trough dust leads, but as noted earlier, it was directly related to the Phase 03 blood lead levels. Neither the cost of lead hazard control activities nor the total project cost was not found to be a significant predictor of blood lead or any of the dust lead levels six months after the intervention.

Early results from a twelve month post-intervention model of blood lead changes support the findings described above for the six month post-intervention model. At this time, only 176 children and dwellings are included in this analysis. More details of this and previous analyses are presented in the Compendium of Tables.

VII. Treatment Failures

Another measure of the effectiveness of an intervention is the longevity of the treatments conducted. The Evaluation was originally designed to monitor all treatments six months and twelve months after the date of clearance. In a subset of the Evaluation units, some grantees have agreed to monitor the treatments (and conduct other follow-up activities such as testing blood and dust) two and three years after the date of clearance. These data will offer an opportunity to compare the failure rates of treatments at each of the four points in time.

The measurement of treatment failures will help the Evaluation achieve some of its objectives. The failure of treatments and the subsequent re-establishment of lead based-paint hazards will be examined as a factor that could affect changes in blood and dust lead levels. The failure rates will help describe the longevity of treatments for those treatments that remain intact less than three years. By combining the overall failure rate data with the costs of treatments, cost-effectiveness comparisons will be possible.

As of this interim report, the grantees had submitted enough follow-up inspection data to take a preliminary look at the rates of treatment failure. The treatment failure rate is defined as the number of times that inspectors identified a failure of a specified treatment divided by the number of times the treatment was performed in the inspected dwellings. Treatments (and treatment failures) are reported here on a per room basis. Midway through the Evaluation, grantees began recording the failures by the extent of failure (i.e., square footage) as well. At this time, there is not enough of this more precise information to examine failures by the extent of failure.

Treatments rarely failed during the first year after lead hazard control. Of the 20 most frequently used treatments, the failure rate was generally two percent or less at six months and slightly higher at twelve months (**Exhibit 51 and 52**). A small set of treatments, however, appear to have higher than average failure rates. Grantees reported that the paint stabilization and rehanging of doors was the poorest performing treatment. It had failed at Phase 03 in 14 percent of the rooms where it was performed and in 25 percent of the treated rooms at Phase 04.

Exhibit 51: Frequency and Percentage of Failures Occurring in Phase 03 (Six Months Post-Intervention) for the Twenty Most Commonly Applied Specmaster Treatments

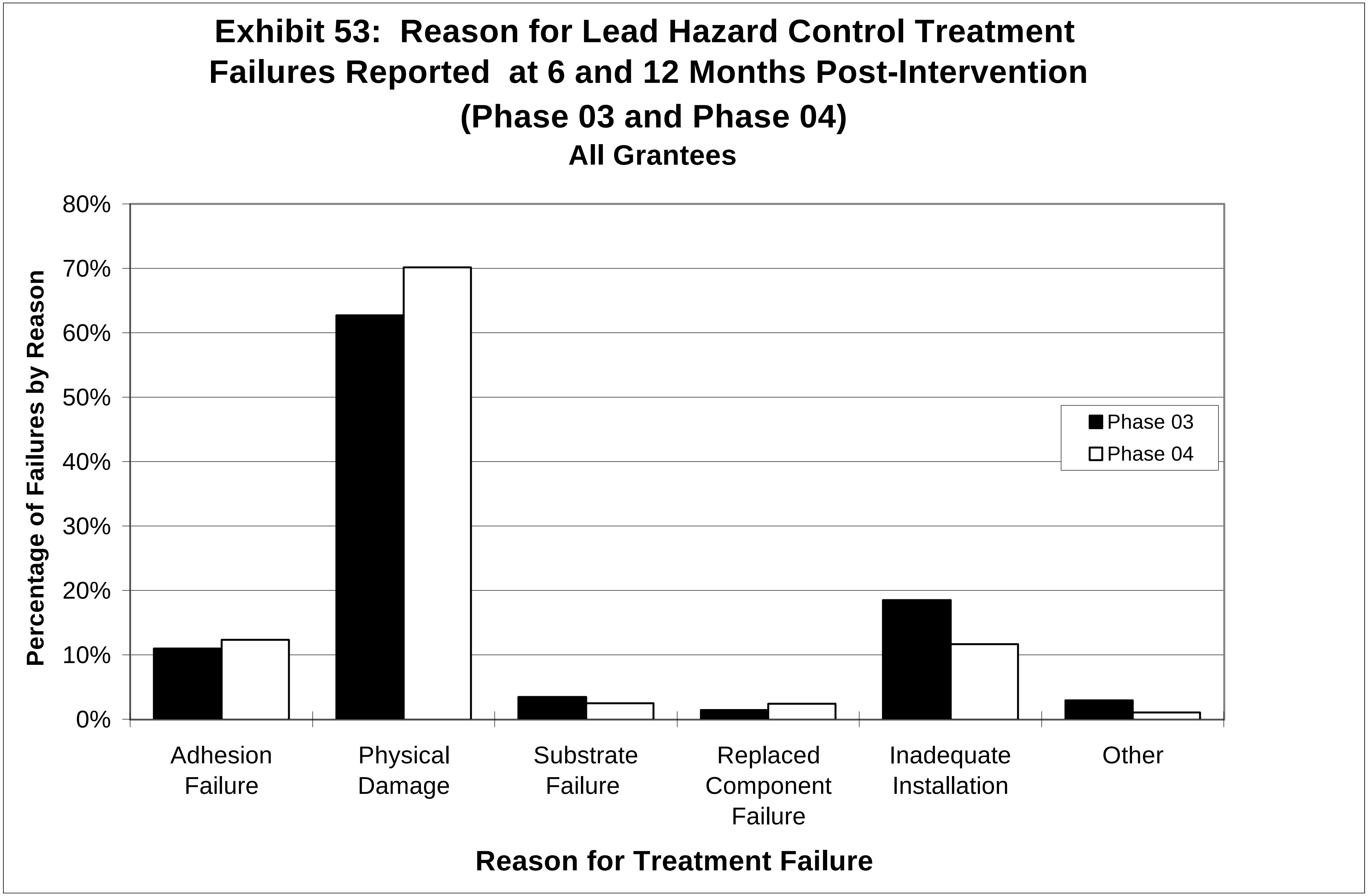
Specmaster Number	Frequency of Use	Frequency of Failure	Percent Failure	Description of Specmaster Treatment
9547	2399	138	6	Trim Stabilize and Prime
9495	1348	190	14	Stabilize, Plane & Adjust Door
9170	1283	20	2	Prep Wall/Surface for Painting
9161	1020	18	2	Surface, Interior-Stabilize Acrylic
9454	1019	21	2	Windows-Install Vinyl Window Unit
9456	702	12	2	Window-Install Vinyl Window, Stabilize Casing and Sill
9436	626	0	0	Window-Install jamb liner, Cover Trough
9482	558	0	0	Window-Remove
9451	521	7	1	Wood Replacement Window Unit
9424	478	4	1	Wood Window-Stabilize, Acrylic
9463	468	15	3	Window-Scrape Sill, Cover Trough
9160	403	36	9	Surface, Interior-StabilizeAcrylic
9537	339	15	4	Door Sill-Heat Gun
9532	334	5	1	Door Exterior-Replace Metal Prehung
9491	329	1	0	Door Stabilize and Paint
9514	320	1	0	Door-Remove
9365	316	17	5	Floor Enclosure Underlay & VCT
9496	307	1	0	Door-Strip Strike Rail & Jamb
9551	303	2	1	Trim Remove
9576	296	12	4	Trim-Replace Historic

Data from: Form 25 and Specmaster
Data as of: September 1, 1997
Source of Data: UC Table 370-03

Exhibit 52: Frequency and Percentage of Failures Occurring in Phase 04 (Twelve Months Post-Intervention) for the Twenty Most Commonly Applied Specmaster Treatments

Specmaster Number	Frequency of Use	Frequency of Failure	Percent Failure	Description of Specmaster Treatment
9547	2013	146	7	Trim Stabilize and Prime
9495	1171	298	25	Door - Adjust and Stabilize
9454	985	24	2	Window-Install Vinyl Window Unit
9170	663	26	4	Prep Wall/Surface for Painting
9161	641	12	2	Surface, Interior - Stabilize, Acrylic
9456	578	16	3	Window-Install Vinyl Window, Stabilize Casing and Sill
9436	396	1	0	Window-Install jamb liner, Cover Trough
9365	348	18	5	Floor Enclosure Underlay & VCT
9463	326	27	8	Window-Scrape Sill, Cover Trough
9451	302	1	0	Wood Replacement Window Unit
9496	294	7	2	Door Strip Strike Rail and Jamb
9160	284	19	7	Surface, Interior - Stabilize, Acrylic
9424	237	15	6	Wood Window-Stabilize, Acrylic
9537	227	20	9	Door Sill -Heat Gun
9482	201	0	0	Window-Remove
9576	201	2	1	Trim-Replace Historic
9509	193	20	10	Door-Replace w/Hollow Core
9628	180	8	4	Stabilize and Paint-Alkyd
9450	174	6	3	Window-Replace/Single Glazing
9571	172	10	6	Trim Strip-Scrapers

Data from: From 25 and Specmaster
Data as of: September 1, 1997
Source of Data: UC Table 370-04



Data From: Form 25 (Phase 03,04)
Data as of September 1, 1997
Source of Data: UC Table 376

Exhibit 53 describes the reasons for treatment failure as reported by the inspectors. The most common reasons for failure (about 80 percent of the failures) were human-related, either physical damage or inadequate installation. Physical damage can range from paint damaged by opening and closing doors and windows to holes in components. The other commonly stated reasons for treatment failure were adhesion and substrate failure. These failures may have been caused by poor surface preparation or moisture/water damage.

The Evaluation asked inspectors to note if treatments failed, even if they did not create a lead based-paint hazard. For example, a replaced window that did not work after six months would be recorded as a failure. While such a finding will not help with the objective of explaining changes in blood and dust lead levels, it may be relevant to the cost-effectiveness of treatments. A cheaply installed replacement component may appear to have a much greater cost advantage over other treatment methods than is justified.

PLANS FOR FUTURE ANALYSES

Component Treatment Costs

In the interim findings section of this report, the costs of performing interventions on a dwelling unit basis by strategy and building type are discussed. Such a method of reporting cost is a useful way to describe the costs of the different levels of interventions as defined by this Evaluation. In addition, the dwelling unit costs may offer guidance to practitioners who want to find out some "ballpark" costs of various intensities of work before selecting a treatment strategy that is compatible with their budget. Yet, as displayed on Exhibit 23, there is often a broad range of costs within a particular strategy. If the success of a project depends on final costs coming within 10-20 percent of estimate, this pricing data will not be very helpful.

One of main objectives of the Evaluation is to describe the costs of various lead hazard control treatments for different building components (i.e., how much does it cost to replace 12 windows, to stabilize 100 square feet of paint, to clean eight rooms, etc.). The Evaluation has begun to search for these answers, but it is not prepared to present any conclusive findings at this time. This section of the report will discuss the analyses that have been conducted to date, the limitations of these efforts, and how some of these limitations will be resolved in the next year so that the specific lead hazard treatment costs can be presented in the final report.

Cost Variation by Locality

In theory, a project designer should be able to arrive at a more precise total cost estimate for the job if each specific treatment and its cost is known. Unfortunately, even when a project is explicitly defined, the treatment costs may not be easily estimable from a national database. Wide differences in costs exist from city to city depending on the number of contractors/ workers available, the local materials and labor market, and the general maturity of the lead hazard control market (i.e., contractors understand the scope of work).

Using specific treatment costs reported by the grantees, a preliminary table of median costs by grantee has been developed (**Exhibit 54**). The primary purpose of this table is to get an idea of the range of the individual treatment costs across grantees. The table will eventually highlight the differences in costs that different localities face. Due to the inherent nature of cost reporting in the Evaluation, however, it is not appropriate to use the specific cost estimates presented here without considering all the possible influential factors.

Other Factors Contributing to Cost Variation

Costs of the same treatment can also vary within a city depending on the contractor and the contractor's bidding procedure. Treatment costs can be influenced by factors such as the quantity of a product (e.g., single replacement window vs. 12 replacement windows), the brand, and the quality of the product. Even with all other factors that influence cost being equal, the cost of a treatment may depend on the extent of the treatment. For example, the cost per square foot of repainting 200 square feet of a wall is likely to be less than the cost of repainting one square foot of a wall.

In a very large database of information, a distribution of these factors would exist so that the median treatment cost will take the range of these factors into account. For example, the costs of the contractor with the high labor and/or material costs would be mixed with the costs of

Exhibit 54: Median Specification Costs by Grantee

Spec Costs Presented when: Specs used at least 25 times by a Grantee, by at least 3 Grantees, and Total Specmaster Cost is within 20% or $200 of Form 23 Lead Hazard Control Cost Adjusted for General Requirement Costs*

Component System	Slug (Specification Title)	SPEC No.	UNIT	Grantee Min	Grantee Max	AC	BA	BO	CA	MA	ML	MN	RI	VT	WI
Wall/Ceiling	LAMINATE 3/8" GYPSUM	9198	SF	$1.98	$2.31		$2.31	$2.22			$1.98				
Wall/Ceiling	STABILIZATION-LIMITED SURFACE	9160	SF	$0.54	$2.57			$2.57		$2.06			$0.54	$1.00	
Wall/Ceiling	STABILIZE AND PAINT ACRYLIC	9161	SF	$0.76	$4.34	$1.25	$1.00	$3.02			$1.13	$4.34	$1.12	$0.76	
Wall/Ceiling	STABILIZE CEILING	9209	SF	$0.75	$1.69		$1.00						$1.69	$0.75	
Doors	DOOR-STABILIZE & PAINT-ACRYLIC	9491	EA	$47.40	$180.00	$130.00					$47.40	$180.00			
Doors	DOOR-STABILIZE PLANE, ADJUST	9495	EA	$60.00	$116.00	$116.00	$60.00				$85.30		$95.60	$90.00	
Trim	STRIP DOOR SILL	9537	EA	$20.00	$40.00		$20.00			$36.50			$30.00	$40.00	
Trim	TRIM STABILIZE AND PAINT ACRYLIC	9547	LF	$1.00	$5.25	$5.25	$1.00	$1.70	$3.62		$1.81	$4.35	$1.43	$1.50	
Trim	TRIM—STRIP WITH SCRAPERS	9571	LF	$1.32	$3.56			$1.32		$1.72				$3.56	
Windows	STABILIZE WINDOW-ACRYLIC	9424	EA	$50.40	$138.00	$116.00			$50.40		$65.20	$138.00			
Windows	VINYL DH, DG WINDOW	9454	EA	$228.00	$500.00	$500.00		$315.00		$250.00		$320.00	$228.00		
Windows	VINYL DH/DG STABILIZE WC & WIS	9456	EA	$200.00	$443.00		$290.00	$207.00			$420.00			$200.00	$443.00
Windows	WOOD REPLACEMENT WINDOW UNIT	9451	EA	$226.00	$558.00	$554.00						$558.00		$226.00	
Ext. Walls/Trim	EXT. STABILIZE AND PAINT ACRYLIC	9627	SF	$0.75	$5.50	$2.74				$2.18	$1.27	$5.50		$0.75	
Ext. Walls/Trim	STABILIZE AND PAINT ALKYD	9628	SF	$1.53	$3.70		$1.53	$3.70			$2.46				

Notes: All values are rounded to three significant digits

The Grantee minimum is the minimum of the grantee medians. The Grantee maximum is the maximum of the grantee medians.

*When the general requirement (overhead) costs were presented separately from the treatment costs, the general requirement costs were aggregated and then proportioned to the treatment costs based on each treatment's contribution to all treatment costs.

Data from: SpecMaster Export and Form 23 (Accepted Forms Only)

Data as of: September 1, 1997

Source of Data: NCLSH Table C8-C

low-cost contractor. The Evaluation, however, does not always have access to such a broad mix of data. Given the constraints of the project designs and bidding requirements of the grantees, a grantee often selected only one or two contractors to perform its lead hazard control activities. Grantees were neither instructed to attempt to standardize costs by adjusting for any or all of the above factors that influence costs nor to report the factors. However, through interviews with the grantees, the final report should be able to identify a number of the programmatic factors that affect the costs.

<u>Limitations to Data Analysis Caused by Reporting Differences</u>

Of more concern at this time are reporting differences that may exist between grantees. Although some of the variation between grantees that is seen in the table reflects true locational differences, some variation reflects differences in the manner in which grantees define their costs. The costs are supposed to represent the total costs for a treatment including labor, materials, overhead (including worker and occupant protection costs) and profit. Other costs such as environmental testing, and occupant education and relocation costs should not be included.

At this time, it is apparent that not all of the data were submitted in this manner. For some dwellings, the cost that grantees report paying to the contractor does not match the total of the individual lead hazard treatment costs. To address this problem, only dwellings with total lead hazard control treatment costs that fall within the quality control criteria for reporting costs (total lead treatment costs were within 20 percent or $200 of the lead hazard control costs reported on Form 23) are included in Exhibit 54. The use of these criteria resulted in the exclusion of the specific treatment costs from approximately 14 percent of the dwellings.

Another attempt to equalize some of the reporting differences across grantees has also been made. Some grantees reported overhead costs (i.e., waste removal, insurance) as a separate line item while other grantees included these costs with the prices for the individual treatments. The individual treatment costs on Exhibit 54 have been adjusted so that these overhead costs (or general requirements) are included in all cases. When overhead costs were reported separately, these costs were aggregated and then proportioned to the treatment costs based on each treatment's contribution to all treatment costs.

Over the course of the next year, the exact cost reporting methods of the grantees will be investigated. Dwellings where the cost data are not reported by the standard methodology will be revised by the grantee, adjusted based on information provided by the grantee, retained with explanation, or in the worst cases, excluded from analyses. The final report analyses are expected to present more definitive information about the costs of treatments and the local differences in cost that may exist.

QUALITY CONTROL OVER ANALYTICAL LABORATORIES AND GRANTEE PROGRAM SUPPLIED INFORMATION USED IN THE EVALUATION

Quality Control over Analytical Laboratories used by Grantee Programs

Along with the regular dust wipe, blood and soil samples collected for the Evaluation, Grantee programs also have their participating laboratories analyze samples prepared with known quantities of lead. These *quality control* (QC) samples provide a means of assessing the ability of laboratories to accurately and reliably measure known or "true" values of lead. For dust and soil samples, results which deviate by more than 20 percent from the true value are considered to be in error. For blood samples, results which deviate by more or less than 3 μg/dL of the true value for lead are considered to be in error. A general summary of the results of the quality control program is displayed on **Exhibit 55**.

<u>Dust Wipe Analysis Quality Control</u>

An occasional QC sample measured outside of the acceptable range of recovery is not uncommon. All but one laboratory participating in the Evaluation has reported at least one such value. For a few labs, however, the measurement errors have been more protracted and systematic. As a result, a small fraction of the Evaluation dust data have been excluded from current analyses. Laboratories that have had problems with their analytical findings have been closely monitored. In some cases, laboratories have subsequently met the Evaluation's requirements. For those laboratories, the Evaluation excluded only those portions of the data which were collected during the laboratories' transient problems. In two cases, the Evaluation has recommended that grantees arrange to use other laboratories that analyze lead in dust. All of the suspect data from the offending labs were, or will be, excluded from further analysis.

<u>Blood Lead Analysis Quality Control</u>

As with dust QC samples, it is not uncommon for an occasional blood QC sample to be measured outside the acceptable range of recovery. In one case, the Evaluation recommended that a grantee arrange to use another laboratory to analyze lead in blood. Overall, the Evaluation has found it necessary to exclude very few blood samples from further analyses.

<u>Soil Lead Analysis Quality Control</u>

The collection of soil samples is optional for the grantees. Thus far, all but one QC soil result from seven grantees have all been within the acceptable range.

Quality Control over Grantee Programs Supplied Information Used in the Evaluation

The Evaluation has instituted procedures to determine the accuracy and reliability of information supplied by grantee programs. Diagnostic procedures include a rigorous review of all incoming data (which includes both review of the paper forms and the administration of software which checks for a variety of errors). Additional diagnostic software is used to assess the conformance of grantee programs in meeting Evaluation protocols. Every effort has been made to correct known errors prior to the compilation and analysis of Evaluation data. As of December 1, 1997, 94.6 percent of the Evaluation forms submitted were considered accurate.

Exhibit 55: Results of Field Quality Control Sample Analyses for Dust, Soil and Blood Samples			
Type of QC Sample	**Total Number Analyzed Since the Beginning of the Project**	**Total Number Outside of the Acceptable Limits**	**Percent (%) of Acceptable QC Samples**
Dust	2242	204	91%
Blood	1236	50	96%
Soil	136	1	99%

Data from: Grantee monthly QC report to UC.

Data as of: December 1, 1997.

Source of Data: UC files

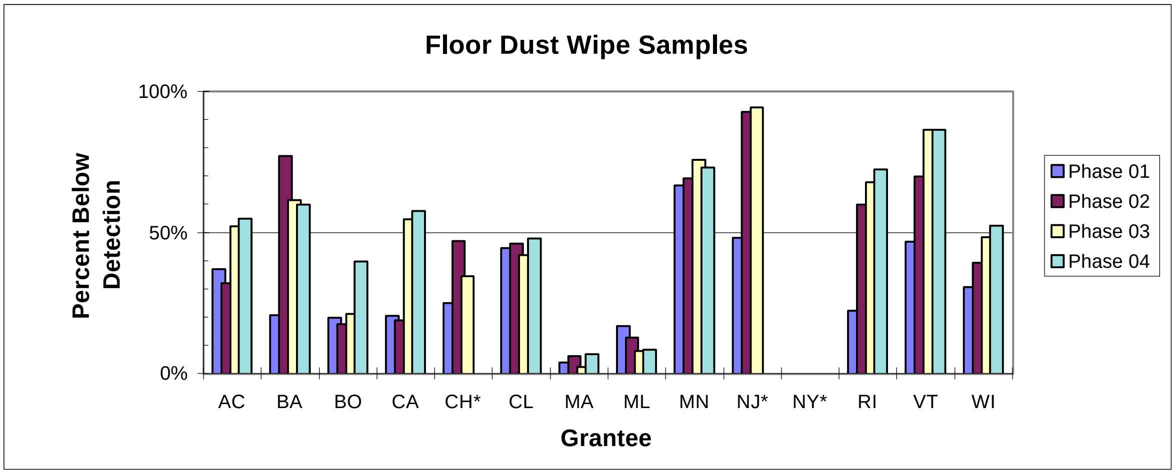
Dust Lead Samples Below Minimum Level Detectable by Laboratory

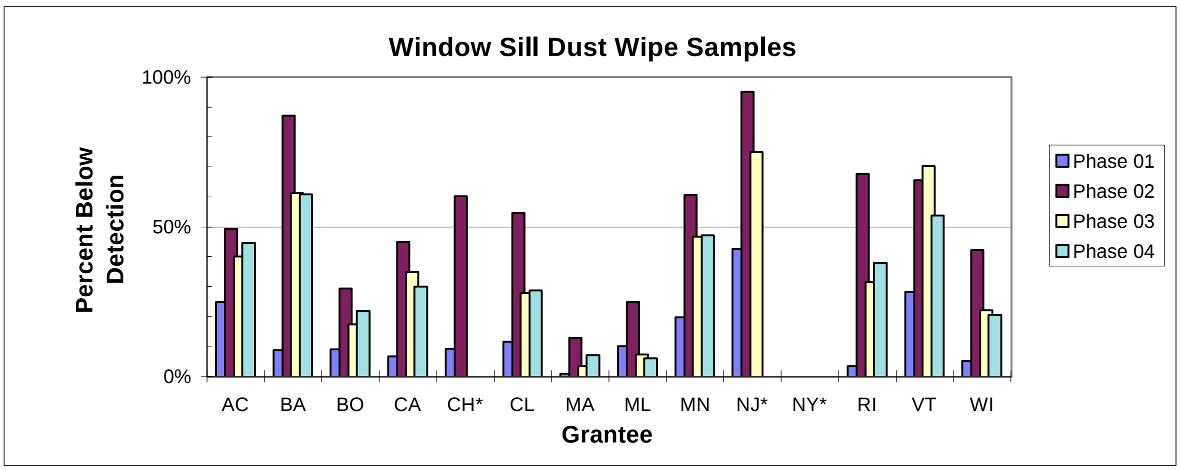
Currently many dust lead values are reported as “below detection level” or “below method reporting level” by the laboratories performing analysis for the grantees, especially for floor dust samples collected after intervention. Seven of the grantees reported that more than half of the floor samples were below the detection limit for at least one of the post-intervention phases (**Exhibit 56**). Over 85 percent of New Jersey’s floor, window sill *and* trough samples were below the detection limit at clearance. Problems arise in the statistical analysis when values are reported as below the detection limit. In order to perform statistical analyses, these values are assigned a number such as the detection limit divided by the square root of two. If samples from two consecutive sample collection phases are each assigned such values, the calculated reaccumulation rate (zero) will not reflect the actual dust lead level changes that occurred. Use of these arbitrary values in place of the “below detection” results can make the calculation of recontamination rates a somewhat meaningless process.

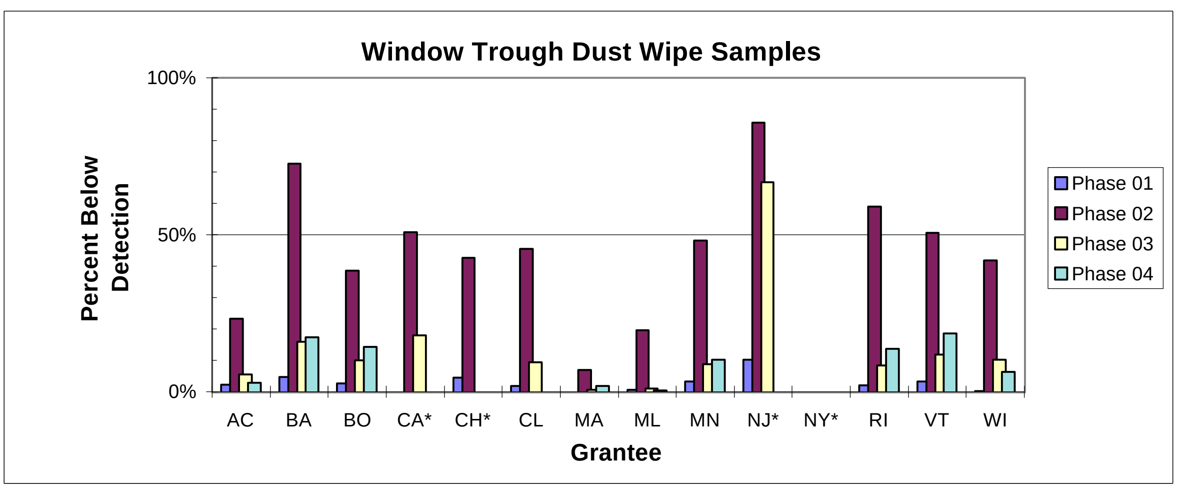
The accurate calculation of a dwelling’s dust lead levels is of paramount importance to the overall success of the Evaluation, because the rate of dust lead reaccumulation represents one of the most important measures of an intervention’s effectiveness. In an effort to prevent further data from being reported as “below detection” and to attempt to deal with dust lead results previously reported as “below detection”, two actions have been initiated:

- HUD has asked the grantees to request that laboratories also report the actual values indicated by their instrumentation for dust wipe samples submitted after November 30, 1997. The availability of actual values will allow the grantees to stop reporting “below detection” values.
- Beginning with a pilot study of data from Baltimore, the UC staff, in cooperation with the laboratory serving Baltimore, are attempting to retrieve instrument values for data previously entered into the data base as “below detection”. To help understand the magnitude of this pilot project, a total of 10,242 dust lead samples from Baltimore were in the data base as of September 1, 1997. Ninety-six (96%) percent of the forms on which these data were recorded contained results from at least one sample that was reported as “below detection”. Once this pilot has been completed, the program will be expanded to the rest of the grantees and as many of their laboratories as are able to cooperate. UC will make the necessary adjustments in the data base to replace the previously-entered “below detection limit” values.

Exhibit 56: Percentage of Dust Lead Wipe Samples Reported as 'Below Detection Level' of the Laboratory by Component, Grantee, and Phase







***Note**: Data not displayed if less than 20 samples reported in a phase.
Phase 03 data not displayed for: New York and Chicago-sills & troughs
Phase 04 data not displayed for: Chicago, New Jersey, New York and California-troughs
Data from: Form 19
Data as of: September 1, 1997
Source of Data: UC Tables 363, 364, 365

APPENDIX

The Third Interim Report (March 1996) and the appendix to the Fourth Interim Report (February 1997) highlighted observations and tendencies of pre-intervention environmental results. For those readers interested in following up on the findings from the that report, the pre-intervention dust, paint and soil exhibits have been reproduced using the additional data that have been submitted since then. In addition, a new figure is presented (**Exhibit APP-3**) that suggests that there is some variation between entry floor samples and other interior floor samples and between bare and carpeted floor samples.

As discussed in the Grantee Progress section, the number of units with reported pre-intervention dust results increased by 50 percent since the last report. The number of reported units with paint tests increased by 78 percent, while units with reported soil results increased by 45 percent. Even with these substantial increases in reported data, the tendencies discussed in the Third Interim Report remain unchanged. That report observed the following findings:

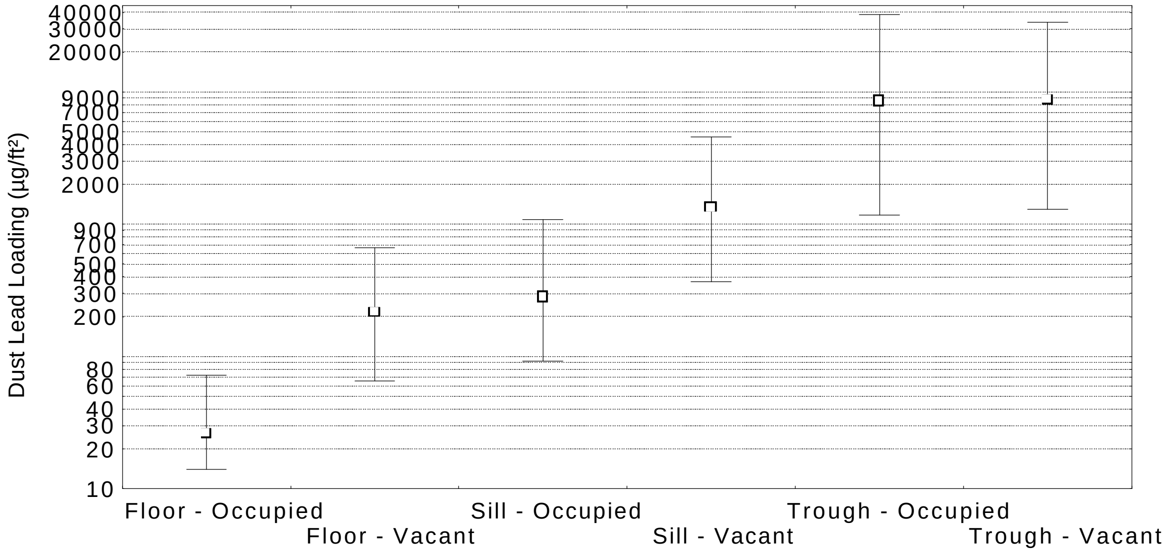
> "Pre-intervention data on lead in paint, dust and soil demonstrate that the dwelling units that have been enrolled exhibit similar patterns as those in previous studies. The levels of lead-based paint are higher on the exteriors of buildings than on the interiors of the dwelling units, while the levels of lead on painted trim are higher than on walls. Dust lead levels are significantly higher on window troughs (wells) than on interior window sills or floor, while sill dust lead levels are consistently higher than floors. Lead levels in soil are higher around the perimeter of the buildings than they are in play areas."
>
> "Although expected patterns are emerging, some interesting variations within the data are present. Pre-intervention dust lead levels on floors and interior window sills in vacant units were about ten times higher than the levels on the corresponding components in occupied units."

While all of the tendencies remain the same, the exact relationship between dust lead levels in vacant and occupied dwellings has changed somewhat. Pre-intervention dust lead levels on floors of vacant units are now eight times higher than floors in occupied dwellings, while levels on interior window sills are now four times higher in vacant units than occupied units. The change reflects the fact that data from Baltimore now make up a smaller percentage of the data about vacant dwellings. Baltimore tends to have a much wider differential between vacant and occupied units than other grantees.

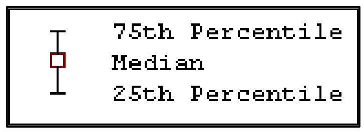
For the first time, comparisons of the dust lead loadings from different types of floor samples are presented in an Evaluation report. Pre-intervention dust lead loadings of floor samples collected just inside the entryway door are likely to be higher than the mean of the other interior floor sample locations. Pre-intervention dust lead loadings on bare (uncarpeted) floors are likely to be higher than loadings on carpeted floors. The median entryway sample on bare floors was 67 percent higher than the median interior bare floor and almost double the median entryway sample on carpeted floors.

Figure APP-1: Pre-Intervention Wipe Method Dust Lead Loading (µg/ft²) by Component and Occupancy -- All Grantees Included

(Logarithmic Scale)



Note: Arithmetic average of each dwelling.
Data From: Form 19
Data as of: September 1, 1997
Source of Data: UC Tables 27A, 27B, 33A, 33B, 37A, 37B.

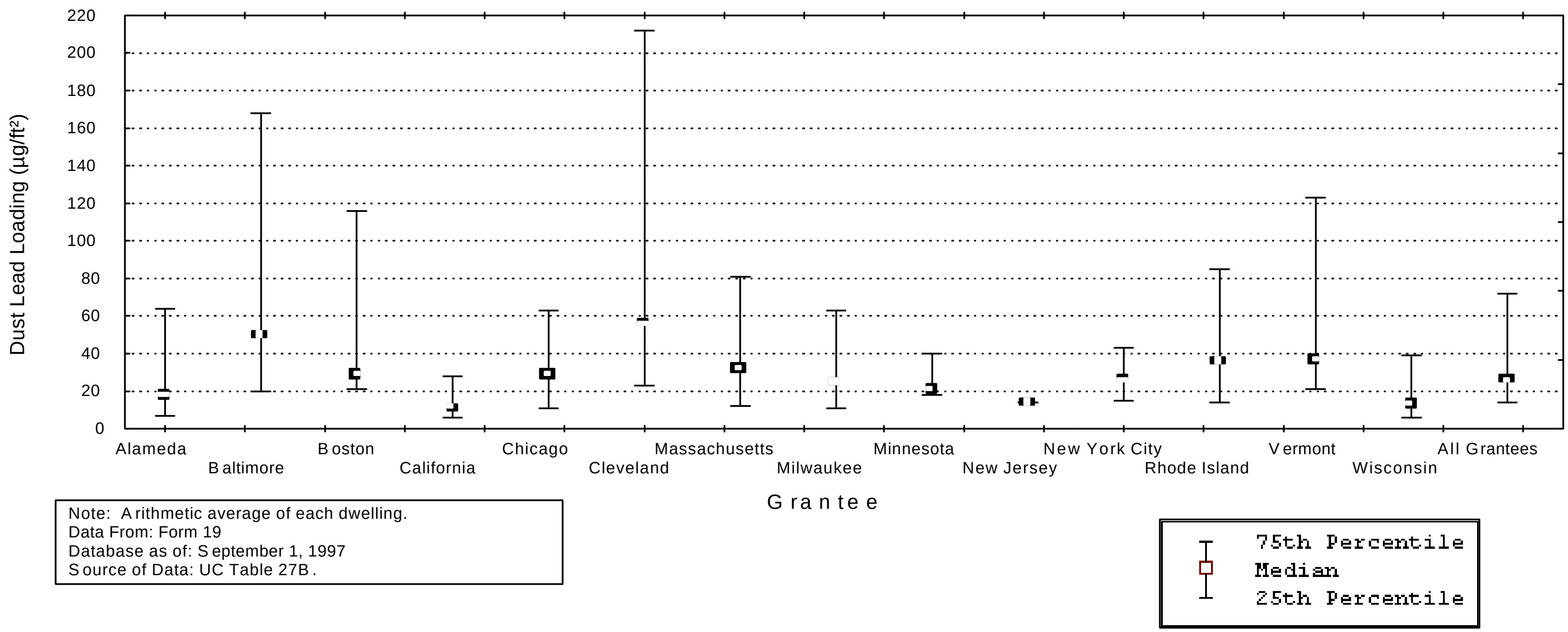


Numeric Values for Figure APP-1

	Floor Occupied	Floor Vacant	Sill Occupied	Sill Vacant	Trough Occupied	Trough Vacant
25th Percentile	14	65	92	369	1176	1300
Median	26	217	281	1336	8455	8700
75th Percentile	72	667	1090	4595	38283	33700
Number of Samples	1851	454	1827	433	1643	407

Figure APP-2: Pre-Intervention Wipe Method Dust Lead Loading (µg on Floors by Grantee-- Occupied Dwellings Only

(Only Grantees with data from at least 25 dwelling units are included)

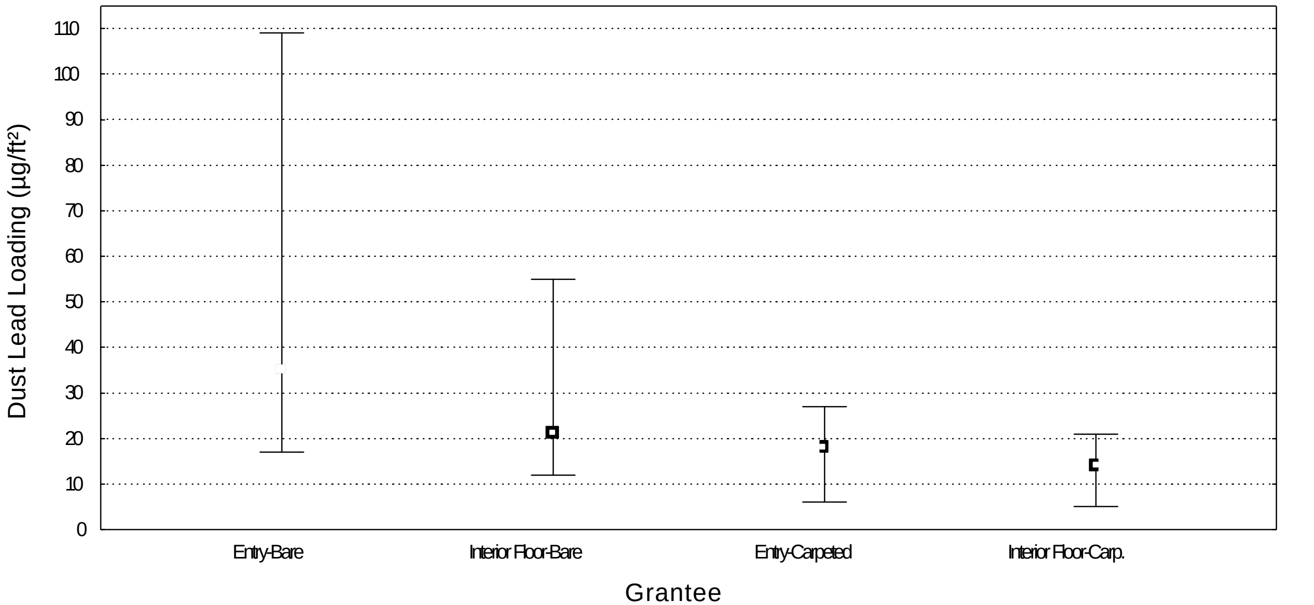


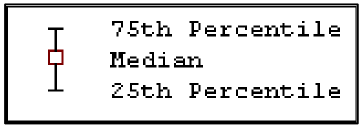
Note: Arithmetic average of each dwelling.
Data From: Form 19
Database as of: September 1, 1997
Source of Data: UC Table 27B.

Numeric Values for Figure APP-2

	Alameda County	Baltimore	Boston	California	Chicago	Cleveland	Massachussets	Milwaukee	Minnesota	New Jersey	New York City	Rhode Island	Vermont	Wisconsin	All Grantees
25th Percentile	7	20	21	6	11	23	12	11	18	14	15	14	21	6	14
Median	18	50	29	11	29	56	32	25	21	14	26	36	37	13	26
75th Percentile	64	168	116	28	63	212	81	63	40	14	43	85	123	39	72
Number of Samples	147	97	65	67	110	92	135	246	164	25	167	132	222	182	1851

Figure APP-3: Pre-Intervention Wipe Method Dust Lead Loading (µg on Floors by Floor Location (Entry and Interior) and Floor Coverin (Bare or Carpeted)--Occupied Dwellings Only



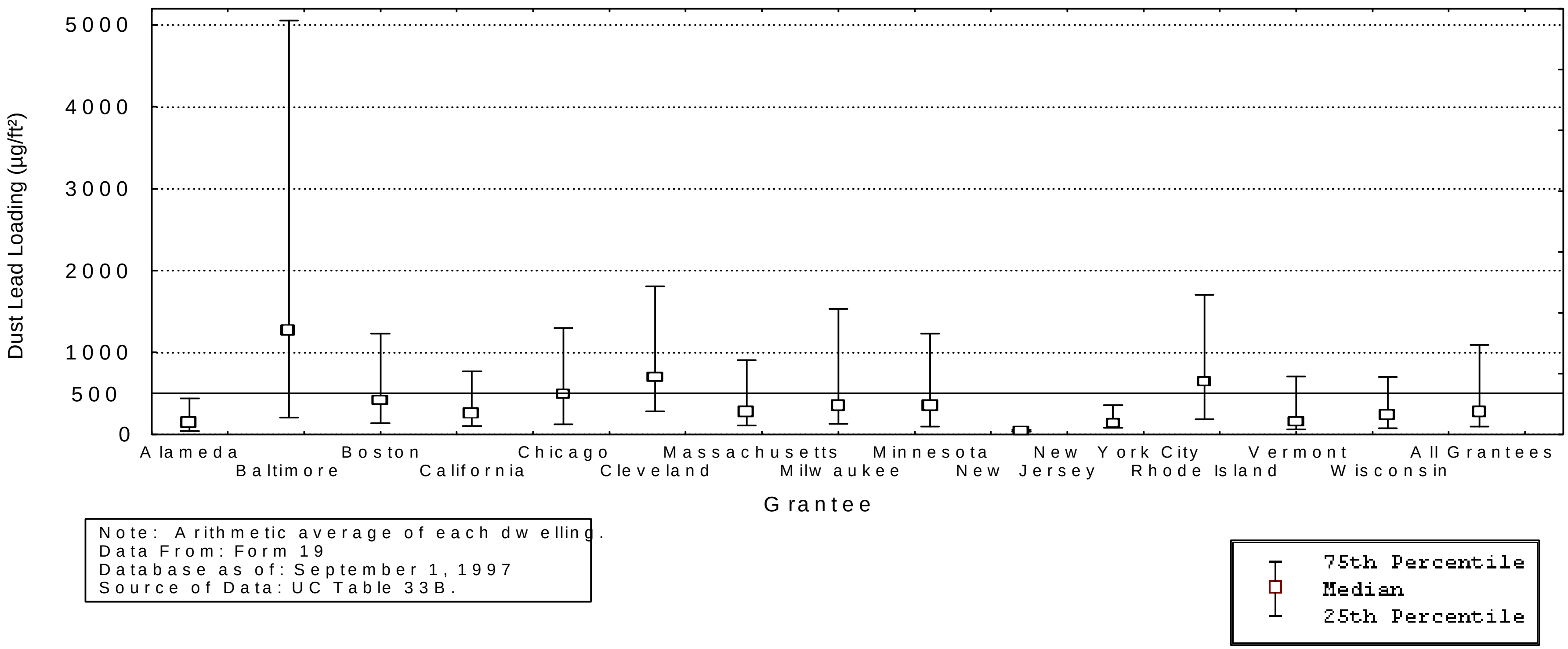


Note: Arithmetic average of each dwelling.
Data From: Form 19
Data as of: September 1, 1997
Source of Data: UC Tables 27-BBE, 27-BBF, 27-BCE, 27-BCF

	Entry-Bare	Interior Floor-Bare	Entry-Carpeted	Interior Floor-Carpeted
25th Percentile	17	12	6	5
Median	35	21	18	14
75th Percentile	109	55	27	21
Number of Samples	1347	1809	452	1015

Figure APP-4: Pre-Intervention Wipe Method Dust Lead Loading (µg/ft²) on Interior Window Sills by Grantee -- Occupied Dwellings Only

(Only Grantees with data from at least 25 dwelling units are included)



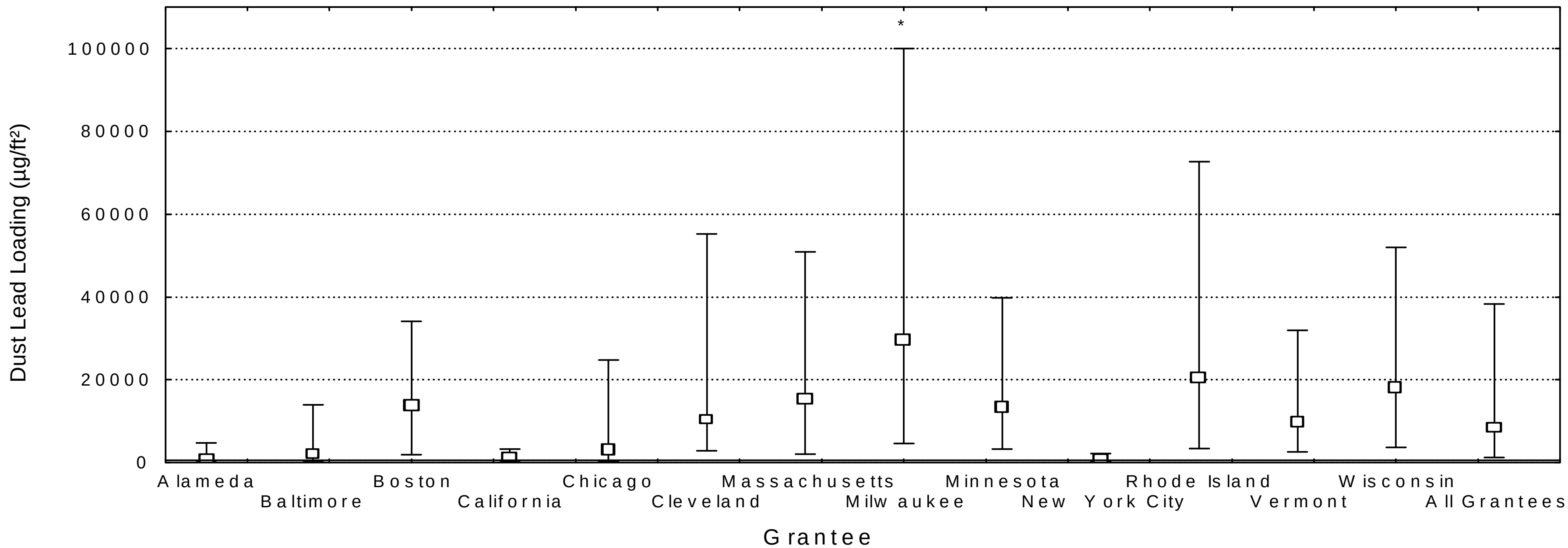
Note: Arithmetic average of each dwelling.
Data From: Form 19
Database as of: September 1, 1997
Source of Data: UC Table 33B.

Numeric Values for APP-4

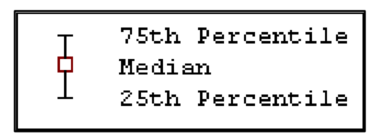
	Alameda County	Baltimore	Boston	California	Chicago	Cleveland	Massa-chussets	Milwaukee	Minnesota	New Jersey	New York City	Rhode Island	Vermont	Wiscon-sin	All Grantees
25th Percentile	42	202	136	101	126	283	111	127	93	34	82	183	64	77	92
Median	148	1271	415	252	491	699	279	355	349	43	136	645	156	243	281
75th Percentile	440	5055	1233	766	1299	1805	905	1535	1227	51	354	1708	706	702	1090
Number of Samples	147	97	65	60	109	90	135	245	162	25	165	132	214	181	1827

Figure APP-5: Pre-Intervention Wipe Method Dust Lead Loading (µg/ft on Interior Window Troughs by Grantee -- Occupied Dwellings Only

(Only Grantees with data from at least 25 dwelling units are included)

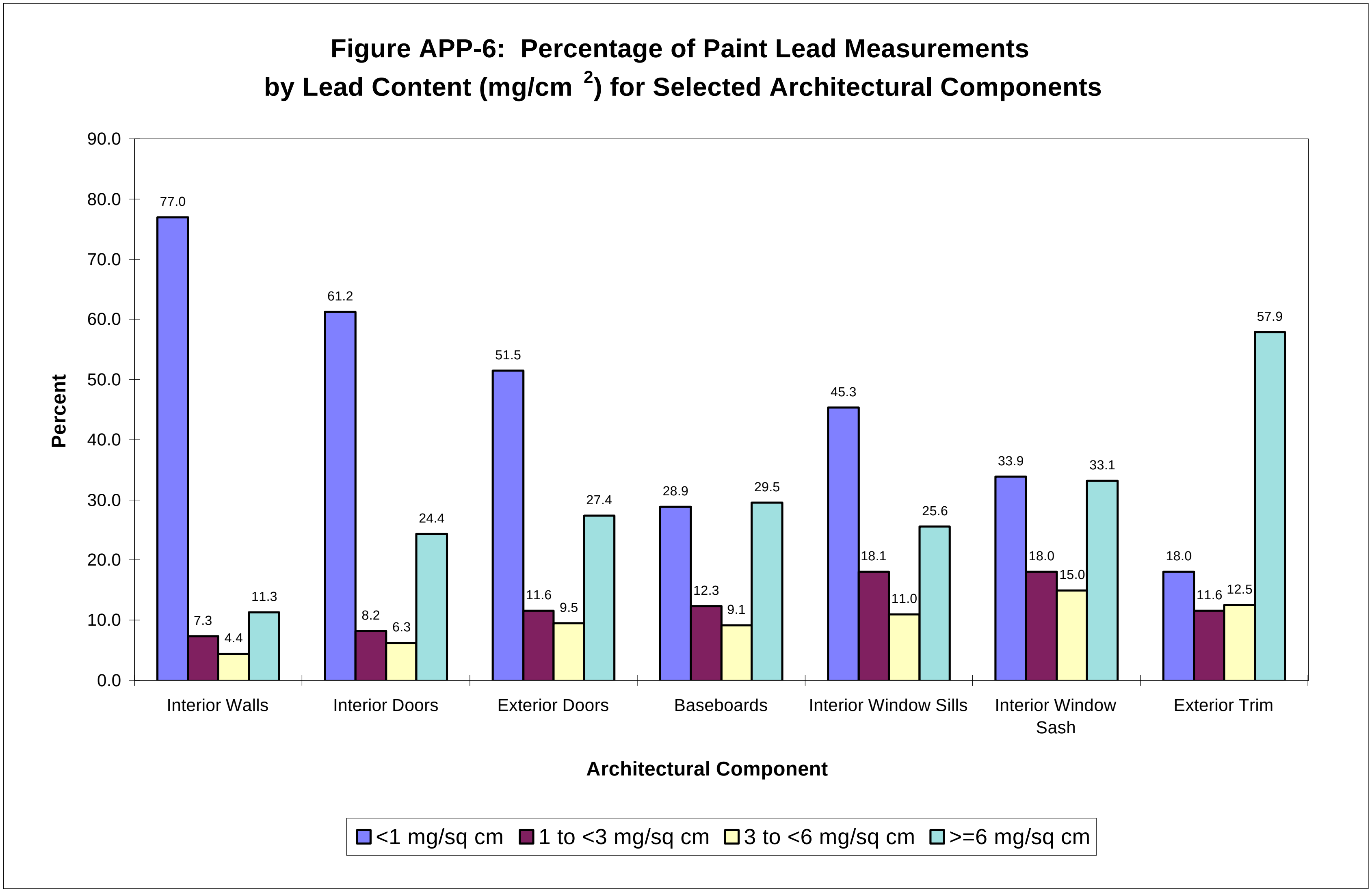


* =Values above 99999 are reported as 99999 due to data input structure.
Note: Arithmetic average of each dwelling.
Data from : Form 19
Database as of: September 1, 1997
Source of Data: UC Table 37B.

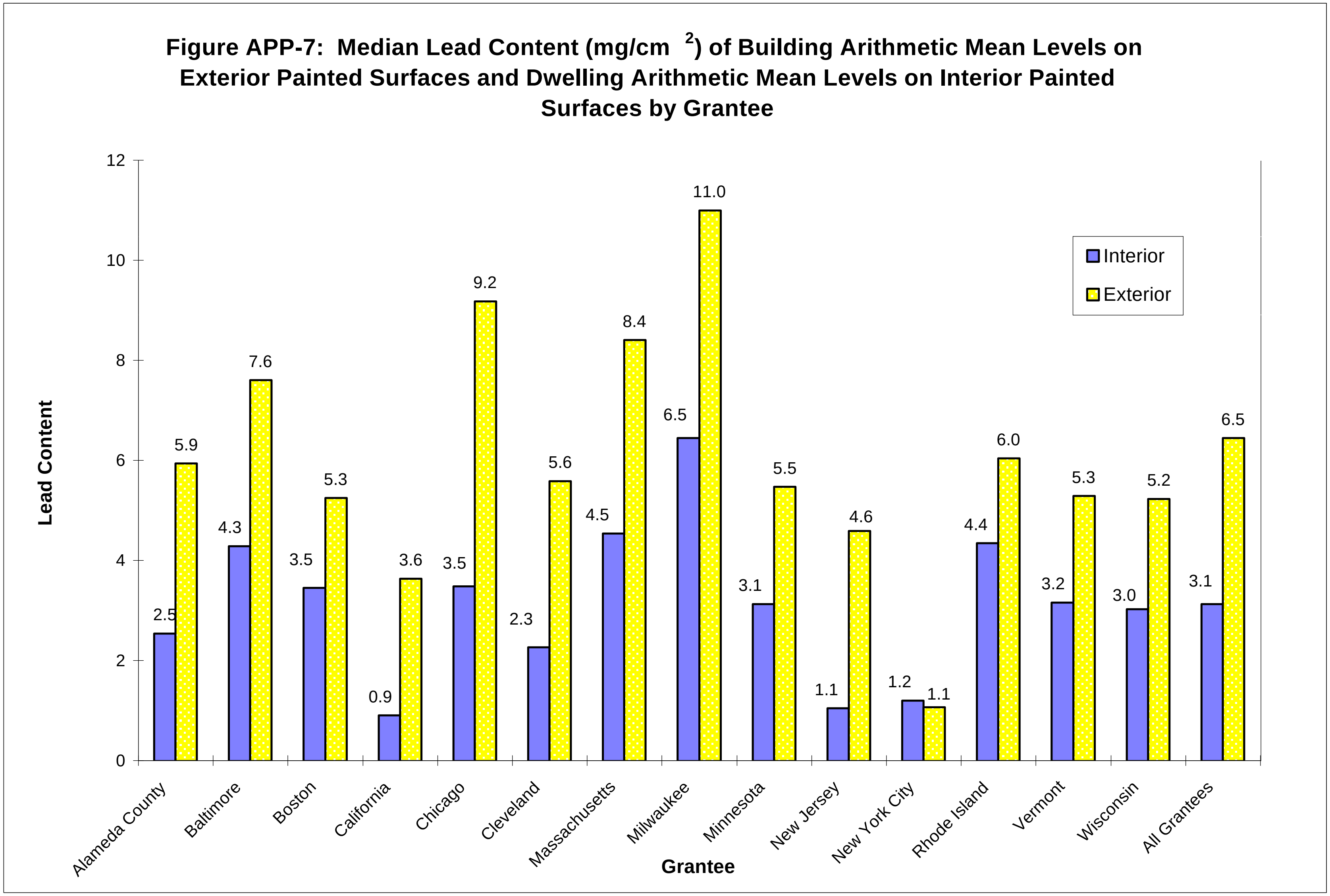


Numeric Values for APP-5

	Alameda County	Baltimore	Boston	California	Chicago	Cleveland	Massa-chussets	Milwaukee	Minnesota	New York City	Rhode Island	Vermont	Wiscon-sin	All Grantees
25th Percentile	344	353	1860	380	252	2819	1972	4625	3182	298	3318	2630	3700	1176
Median	867	2100	13761	1327	3040	10359	15440	29650	13394	726	20425	9820	18173	8455
75th Percentile	4694	14000	34158	3211	24800	55237	50835	99999	39789	2100	72740	32000	52050	38283
Number of Samples	91	95	65	32	91	84	135	240	152	149	126	201	178	1643



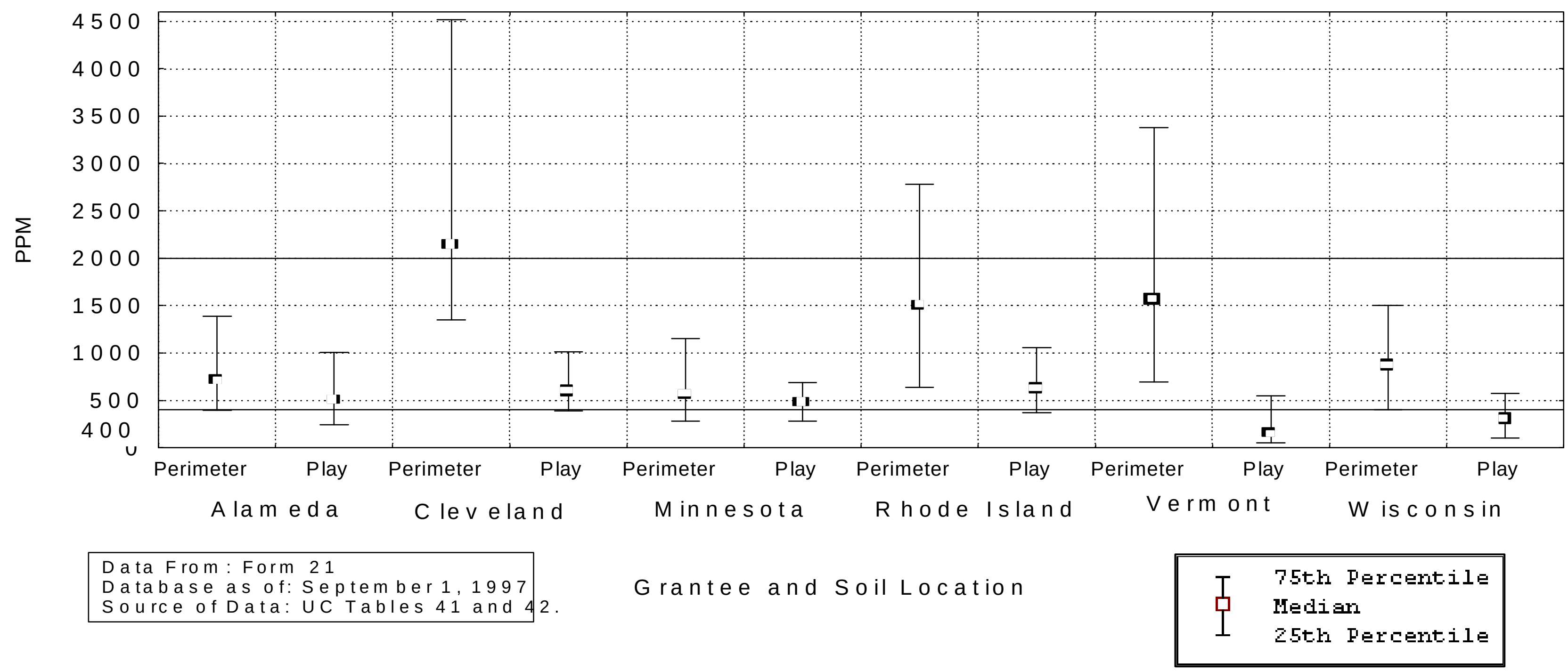
Data From: Form 14, 15 and 16
Data as of: September 1, 1997
Source of Data: UC Tables 062-I01, 062-I03, 062-I05, 062-I06, 062-108, 062-E01, 062-E09



Data From: Form 14, 15 and 16
Data as of: September 1, 1997
Source of Data: UC Tables 099, 101

Figure APP-8: Building Perimeter and Play Area Soil Lead Concentration (ppm) by Grantee

(Only Grantees with at least 25 perimeter soil samples are included)



Numeric Values for APP-8

	Alameda County		Cleveland		Minnesota		Rhode Island		Vermont		Wisconsin		All	
	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample	Building Perimeter Sample	Play Area Sample
25th Percentile	395	241	1350	390	280	284	640	370	692	50	400	100	557	259
Median	710	501	2140	589	560	474	1500	621	1560	144	859	300	1252	481
75th Percentile	1387	1007	4517	1010	1151	687	2779	1057	3380	551	1500	572	2580	870
Number of Samples	97	69	99	99	44	44	60	41	171	20	66	38	557	330